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AMERICAN DYESTUFF REPORTER

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VOLUME 25 | NOVEMBER 2. 1936 | NUMBER 22

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Official Publication of the American Association of Textile Chemists and Colorists

THE OBJECTS OF THIS ASSOCIATION ARE:

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"To encourage in any practicable ways research work on chemical processes and materials of importance to the Textile Industry.

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AMERICAN
DYESTUFF REPORTER

VOLUME 25 NOVEMBER 2, 1936 NUMBER 22

The Measurement of Color of Dyed Textiles

R. D. NUTTING*

THE problem of color measurement and specification has become enormously simplified in recent years through the development of proper instruments. A broader understanding of their uses has been brought about through the publication of numerous articles in trade and scientific journals. It has been shown recently[1, 2] how measurements made with an instrument, such as the spectrophotometer, may be used to define exactly the color of any object in much the same manner as the eye would see it. By taking into consideration the type of illumination under which the object will be seen, three values known as Dominant Wavelength, Purity, and Brightness are determined. These values correspond physically to the more common concepts of hue, saturation, and brilliance, and are found to offer a convenient method for setting up limits of color tolerance[3].

It has been established[4] that the sensitivity of the spectrophotometer exceeds that of the trained human eye for the detection of small color differences. Furthermore, the development of a photoelectric, recording spectrophotometer by Hardy[5] has placed on the market an instrument of the highest precision that presents complete results in the matter of only a few minutes.

The problem now confronting the color technologist is that of utilizing the measurements obtained with the spectrophotometer to the best advantage in his daily routine of work. Probably the most important question to a dyer is, "How much dye must I place upon a piece of material in order to obtain a definite color?" The answer to such an apparently simple question is not, unfortunately, so easy to obtain. Assuming, for the moment, that the complicated mechanical and chemical processes of placing the correct amount of dye upon the cloth are completely under the control of the dyer, there still remains the question of how many pounds of dyestuff on each pound of cloth will produce a certain color, or match a given sample.

It has been shown in a previous article[2] that two materials are a complete match in color when, and only when, their spectrophotometric curves are identical. It is frequently found that materials having different spectrophotometric curves match quite well under one particular source of illumination. But their fundamental dissimilarity is made painfully apparent when they are observed under different conditions of lighting. The problem, then, is limited to the process of obtaining a correlation between the amount of dyestuff on a known weight of cloth and the spectrophotometric curve of this dyed material.

This question of correlating the amount of dyestuff on cloth with the resulting spectrophotometric curve has been considered before and has been attacked with some success by Shelton & Emerson[6], Cohoe[7], and Guelke & Fitzsimons[8]. The purpose of this paper is to show that the optical laws governing the absorption of light by transparent materials, such as clear dyestuff solutions, may be applied in an analogous way to the absorption of light by dyed textiles.

In the discussion that follows, it should be remembered that an object appears "colored" because some of the portions of the light that strike it are absorbed more than others. These portions of light are designated by their wavelengths and light of only one wavelength will be dealt with at a time. The laws applying to light of one

*Senior Fellow, The Textile Foundation. Present address: Krebs Pigments Department, E. I. du Pont de Nemours & Co., Inc., Curtis Bay, Md.

[1] D. B. Judd, "The I. C. I. Standard Observer & Coordinate System for Colorimetry." J. Opt. Soc. Am. *23*, 359 (1933).

[2] R. D. Nutting, "The Objective Specification of Color." Am. Dyestuff Reptr. *24*, 583 (1935).

[3] R. D. Nutting, "Color Tolerance: Its Measurement & Specification for Dyed Textiles." Am. Dyestuff Reptr. *25*, 1, (1936).

[4] R. D. Nutting, "The Detection of Small Color Differences in Dyed Textiles." Am. Dyestuff Reptr. *23*, 251 (1934).

[5] A. C. Hardy, "A New Recording Spectrophotometer," J. Opt. Soc. Am. *25*, 305 (1935).

[6] E. M. Shelton & R. L. Emerson, "The Specifications of Color on Dyed Fabrics by Spectroanalysis." Ind. & Eng. Chem. Anal. Ed. *4*, 248 (1932).

[7] W. P. Cohoe & E. R. Cohoe, "The Determination of Substantivities of Dyes." Ind. & Eng. Chem. Anal. Ed. *4*, 112 (1932).

[8] R. Guelke & M. Fitzsimons, "Effect of Dyes on the Reflection of Light from Textiles." Trans. Farady Soc. *30*, 512 (1934).

wavelength (frequently designated as monochromatic light) apply equally well to light of any other wavelength in the visible spectrum.* Therefore, this restriction is no limitation to the use of these laws in a general way.

We will consider first the simple case in which light passes through a cell containing a solution of dyestuff, onto a piece of undyed cloth, as illustrated by Figure 1.

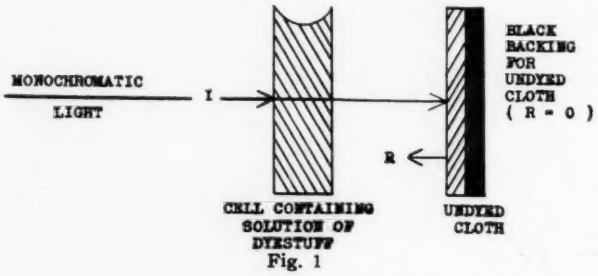


Fig. 1

The portion of light that was not absorbed after passing through the cell of dyestuff** and after having been reflected by the cloth is measured with the spectrophotometer and may be designated as R. If the amount of dyestuff in solution is changed, it is only natural to expect that the value of R will change accordingly. This we find to be true, and, as the concentration of dyestuff increases, the amount of reflected light, R, decreases. These changes have been measured with the spectrophotometer and are shown graphically in Figure 2.

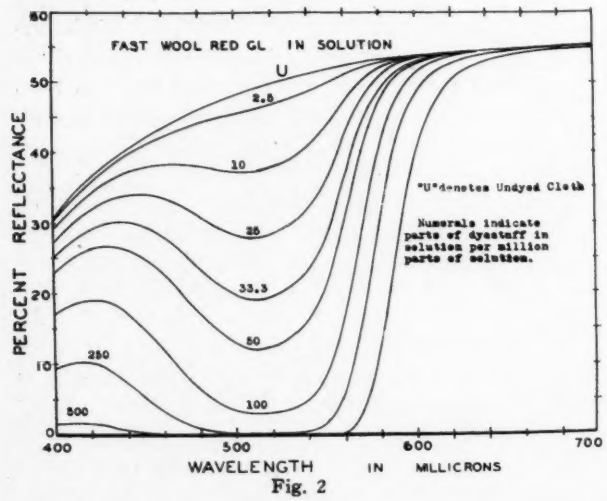


Fig. 2

This diagram illustrates several things. It indicates that increasing the concentration of dyestuff decreases the amount of reflected light, and it shows also how each portion of the spectrum is affected by these changes in concentration. It is apparent that some portions of the spectrum are affected more than others, and for this particular dyestuff the wavelength of greatest change occurs at 510 mμ (millimicrons).

This wavelength of maximum absorption or greatest change, 510 mμ, may be connected very definitely with the amount, or concentration, of the dyestuff present if a correction is made for the reflection of the undyed cloth. The measurements made with the spectrophotometer were so arranged* that the light lost by reflection and absorption of the cell containing the dyestuff was canceled out and may be neglected. For reasons that will be made clear later on, we are interested not so much in the light that is reflected or transmitted by our system shown in Figure 1, but by the amount of light absorbed.

The amount of light incident upon the system is designated by I and the fractional quantity of light not absorbed by R. If R_u denotes the light reflected by the woolen material alone, then the amount of light absorbed by the wool is A_u, equal to $(I-R_u)$; that absorbed by the entire system is A, equal to (I-R). Since I represents all of the incident light, I=1 and the following equations may be written:

Light absorbed by undyed wool alone $= A_u = 1-R_u$, or $R_u = (1-A_u)$.

Light absorbed by entire system $= A = 1-R$, or $R = (1-A)$.

The reflection of the entire system, R, may be expressed in terms of the concentration of dyestuff in the cell, C, by a simple expression known as Beer's law. However, it is first necessary to correct for the constant light absorption due to the undyed cloth, since the *percentage* of light reflected from it is unaffected by variations in the amount of dyestuff in the cell. The light transmitted by the dyestuff alone in solution in the cell is expressed by $\frac{R}{R_u}$.

This light is now related to the concentration of dyestuff by the following expression derived from Beer's law:

Equation 1: $$\frac{R}{R_u} = e^{-kC}$$

where e is the base of natural logarithms (2.7183) and k is a constant depending only upon the dyestuff used and the thickness of the dye solution. In other words, for one dyestuff, such as Fast Wool Red GL, measured in a cell of fixed dimensions, k is a constant at a given wavelength and the only variables in the equation are R and C.

This equation may be transformed by taking the natural logarithm of both sides, giving:

*The colors of light in the visible spectrum may be designated broadly by the following wavelength numbers:

Color	*Wavelength*	*Color*	*Wavelength*
Violet	400-450 millimicrons	Yellow	570-590 millimicrons
Blue	450-500 millimicrons	Orange	590-610 millimicrons
Green	500-570 millimicrons	Red	610-700 millimicrons

25,400,000 millimicrons = 1 inch.

**The dyestuff used in this experiment was National Aniline's Fast Wool Red GL and the cloth used in all experiments was No. 2511 gray obtained from the Arlington Mills. This cloth was chosen after much investigation because of its high degree of uniformity, evenness of weave, and absence of foreign matter.

*The Hardy spectrophotometer measures the diffuse reflection of an object relative to the reflection from a standard white magnesium oxide surface. The reflection and absorption of the cell may be canceled out, if so desired, by placing an identical cell filled with pure solvent in the path of the light beam that is directed at the standard white surface. This was done for the measurements discussed here.

$$\log_e\left[\frac{R}{R_u}\right] = -kC$$

Since: $\log_e = 2.303 \log_{10}$

Then: $2.303 \log_{10}\left[\frac{R}{R_u}\right] = -kC$

Or: $-\log_{10}\left[\frac{R}{R_u}\right] = \left[\frac{k}{2.303}\right]C = KC.$

Taking the common logarithm of both sides again, the following equation results:

$$\log_{10}\left[-\log_{10}\left(\frac{R}{R_u}\right)\right] = \log K + \log C.$$

Substituting now for R and R_u gives:

Equation 2: $$\log_{10}\left[-\log_{10}\left(\frac{1-A}{1-A_u}\right)\right] = \log_{10}K + \log_{10}C.$$

It should be possible now to plot $\log_{10}\left[-\log_{10}\left(\frac{1-A}{1-A_u}\right)\right]$ against $\log_{10}C$ and obtain a straight line relationship. This has been done in Figure 3 for the maximum absorption at 510 mμ and the adherence to Beer's law is observed to be nearly perfect.

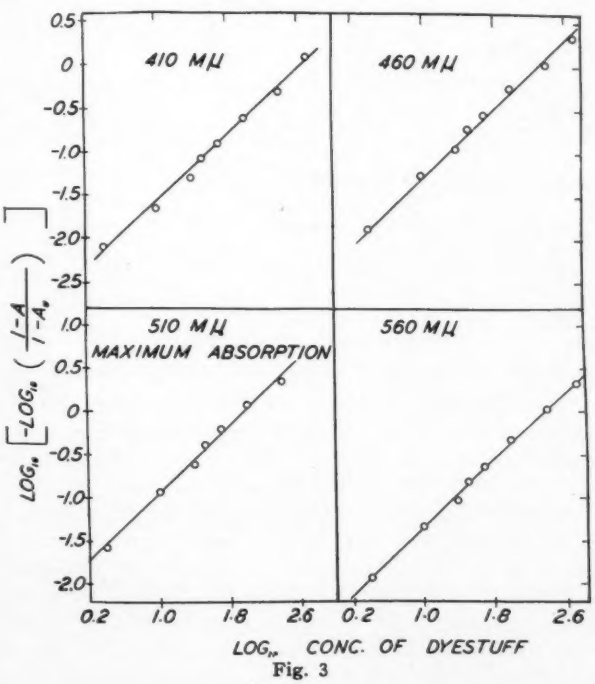


Fig. 3

The same reasoning may be applied, it will be recalled, to measurements made at any other wavelength. The other three curves in Figure 3 bear out this statement quite consistently, and we have now a way of predicting the amount of light absorbed at any wavelength for any concentration of dyestuff. In other words, spectrophotometric measurements are made at one concentration of dyestuff for as many wavelengths as are necessary to define the shape of the spectrophotometric curve. Beer's law is applied as shown above and the spectrophotometric curve at any other wavelength may be calculated directly. The simplest way in which to perform this computation is, perhaps, to construct a graph such as that shown in Figure 4 and to place on it the point represented by the value of $\log_{10}\left[-\log_{10}\left(\frac{1-A}{1-A_u}\right)\right]$ measured at the known concentration $\log_{10}C$. A straight line is then drawn through this point with a slope of 45°. By reading the value of $\log_{10}C$ on the abscissa for any other concentration of dyestuff, C, the value of $\log_{10}\left[-\log_{10}\left(\frac{1-A}{1-A_u}\right)\right]$ may be read directly on the ordinate as illustrated by Figure 4. In order to avoid experimental error, it is better to measure the absorption at two concentrations covering the desired range and to construct Figure 4 from these two points.

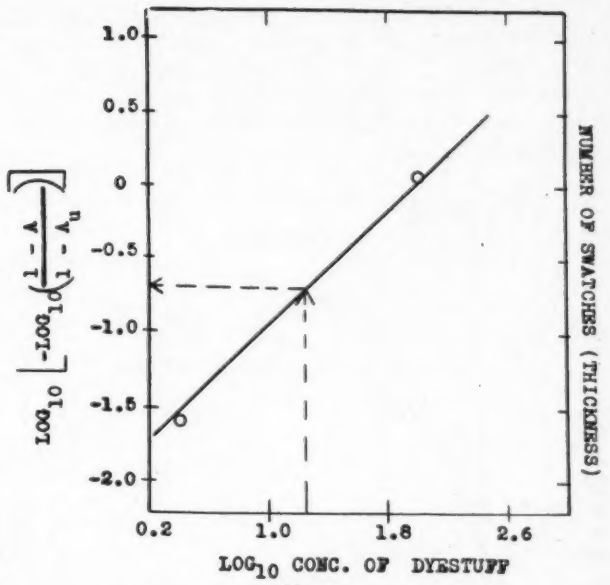


Fig. 4

We are now in a position to study the practical case in which swatches of wool were dyed with various dyestuffs. The method of correlation previously discussed in connection with dyestuff solutions will be shown to be valid for measuring the amount of light absorbed by varying amounts of dyestuff placed on the cloth. It was intended, at the start of this study, to measure the reflection of light from an infinitely thick layer of dyed material, produced by folding the cloth sufficiently so that no light penetrated through the last fold. This plan was abandoned when it was found that the amount of light reflected from a pile of undyed woolen swatches did not increase with an increasing number of swatches (increasing thickness of wool) in the manner predicted by theory. Calculations were made using the method outlined by Steele[9] and these

[9]F. A. Steele, "Optical Characteristics of Paper, No. 1," Paper Trade J. *100*, 37 (1935).

results show graphically in Figure 5 that the measured reflection was always larger than it should have been. This discrepancy may be attributed, in part, to the non-uniformity of the medium, being composed of several layers of cloth rather than one homogeneous layer of increasing thickness.

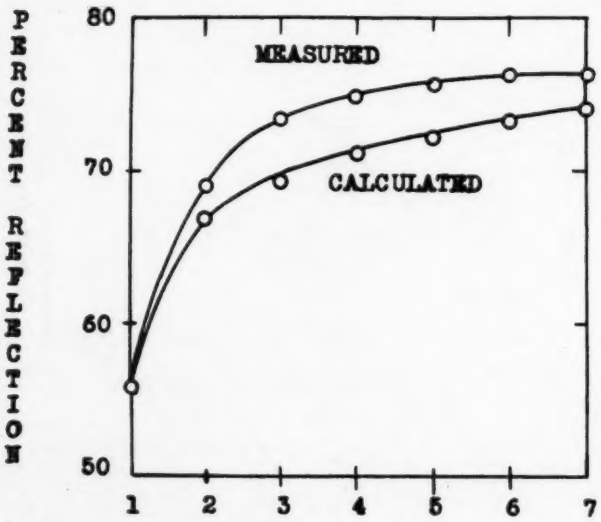


Fig. 5

The desire to avoid non-uniform and unlevel dyeing was another factor in favor of using a small sample of wool. Swatches two inches in diameter, weighing approximately 0.4 gram, were dyed by boiling with suitable amounts of dyestuff, Glauber's salt, and sulfuric acid in glass flasks. The dyed swatches were rinsed with cold water, dried, and measured for transmission and reflection with the spectrophotometer. The exhausted dyebath and rinsings were analyzed for unabsorbed dye by measuring the transmission of the solution spectrophotometrically and applying Beer's law. In this manner, the exact amount of dyestuff deposited on the wool was determined as the difference between the amount initially added to the dyebath and that remaining after the cloth had been removed.

Samples of wool were dyed with Fast Wool Red GL in concentrations from 0.0157 per cent to 9.64 per cent (grams of dyestuff per 100 grams of wool) and the reflections and transmissions from both sides of each sample were measured with the spectrophotometer. The reflection curves for all of the Fast Wool Red GL dyeings have been drawn in Figure 6, starting with the undyed wool, designated "U," at the top of the figure, and descending the page in the order of increasing concentration of dyestuff. A set of spectrophotometric curves for the reflection and transmission of both sides of the sample dyed with 0.15 per cent dyestuff are shown in Figure 7. Similar spectrophotometric curves were measured for each of the other dyeings of this series and the average of the two curves was used in making the calculations.

The equation used earlier to correlate the fractional amount of light absorbed (at one wavelength) by a solu-

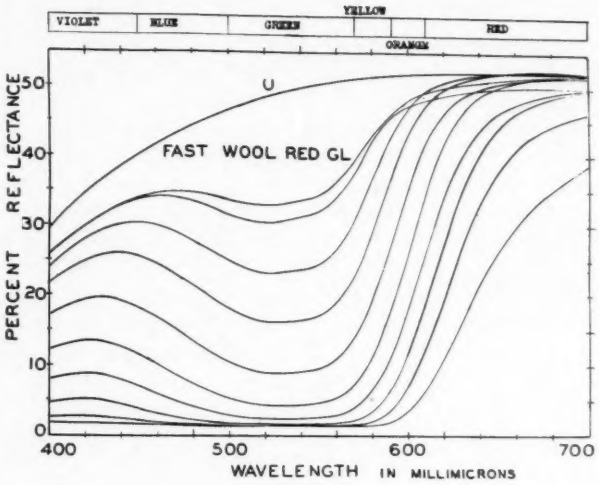


Fig. 6

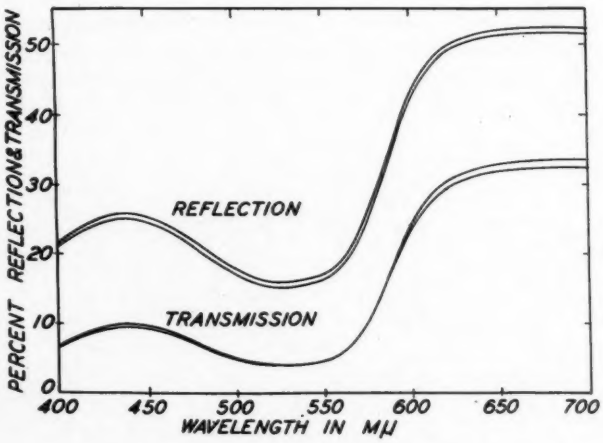


Fig. 7

tion of dyestuff with the concentration of dyestuff in solution will now be applied, by making a minor change in one of the terms. This earlier equation, it will be recalled, was:

Equation 2: $$\log_{10}\left[-\log_{10}\left(\frac{1-A}{1-A_u}\right)\right] = \log_{10}K + \log_{10}C$$

where A = fractional amount of light absorbed by dyestuff solution and undyed wool backing, backed by black.

A_u = fractional amount of light absorbed by undyed wool backing, backed by black.

C = concentration of dyestuff.

K = constant, depending upon the nature of the dyestuff and the length of light path through the dye solution.

The equation for expressing the amount of dye on the cloth in terms of the fractional amount of light absorbed by the cloth is:

$$\textit{Equation 3}: \log_{10}\left[-\log_{10}\left(\frac{\frac{1-A}{A^{\infty}}}{\frac{1-A_u}{A^{\infty}}}\right)\right] = \log_{10}K + \log_{10}C$$

The symbols A and A_u refer to the absorption of the dyed and of the undyed cloth, respectively, while C is the concentration of dyestuff, expressed as parts of dye per 100 parts of cloth. K has a similar significance as before, being a constant dependent upon the type of dyestuff and the length of light path through the dyed wool. The new term, A^{∞}, refers to the fractional amount of light that would be absorbed if an infinite amount of dye were absorbed by the cloth. This term is, in reality, a correction for the surface reflection* of the cloth. It is determined by dyeing the cloth with successive increasing amounts of dyestuff until an additional small increase does not alter further the reflection of light from the samples as measured by the spectrophotometer. It is important that this correction for surface reflection be truly representative of the wool cloth and not caused by loosely held dye particles that are actually unabsorbed by the cloth. This is accomplished by measuring the values from which Aoo is computed near the wavelength of maximum absorption only.

The values of A, A_u, and A^{∞} of the equation are computed quite simply from measurements made directly with the spectrophotometer.

A $= 1-(R+T)$, for cloth dyed at concentration, C.

$A_u = 1-(R_u+T_u)$, for undyed cloth, where C = zero.

$A^{\infty} = 1-(R_{\infty}+T_{\infty})$, for cloth dyed at concentration = infinity.

R = Fraction of light reflected by cloth when backed by a non-reflecting surface, for which R = zero.

T = Transmission of light through cloth.

Equation 3 has been plotted for dyeings made at various concentrations of Fast Wool Red GL and Figure 8 illustrates the correlation obtained at four wavelengths, 420, 470, 520, and 570 mμ. The data are consistent for all except the values for 620 mμ, which are shown in Figure 9. The poor correlation in this case is readily understood by referring to Figure 6. Here it is seen that in the orange and red portions of the spectrum, where little absorption occurs, no regularity is obtained for the light reflected from samples dyed with the smaller amounts of dyestuff. This phenomenon has been noted before[3], but no explanation has been found as yet to account for this anomaly.

The wavelength of maximum absorption for wool dyed with Fast Wool Red GL is 520 mμ, whereas it is only 510 mμ for the dyestuff in water solution. This shift in absorption maximum is a phenomenon characteristic of some dyestuffs and lead to the formulation of the so-

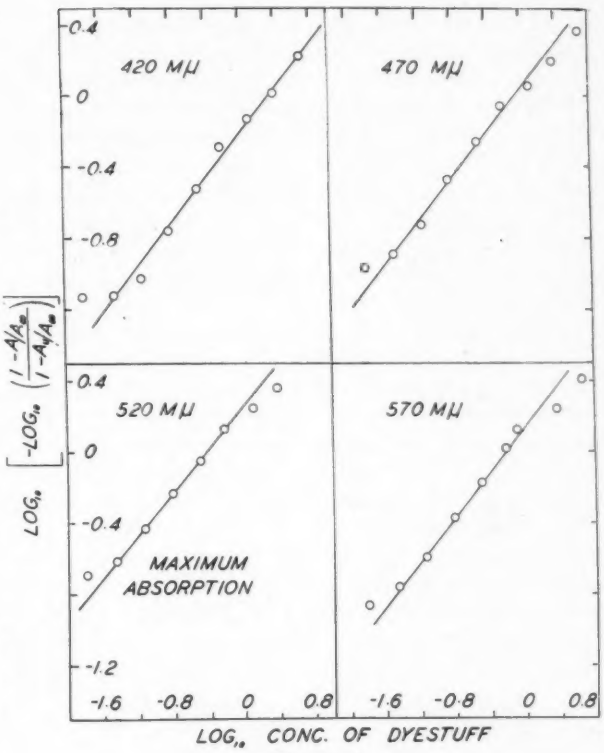


Fig. 8

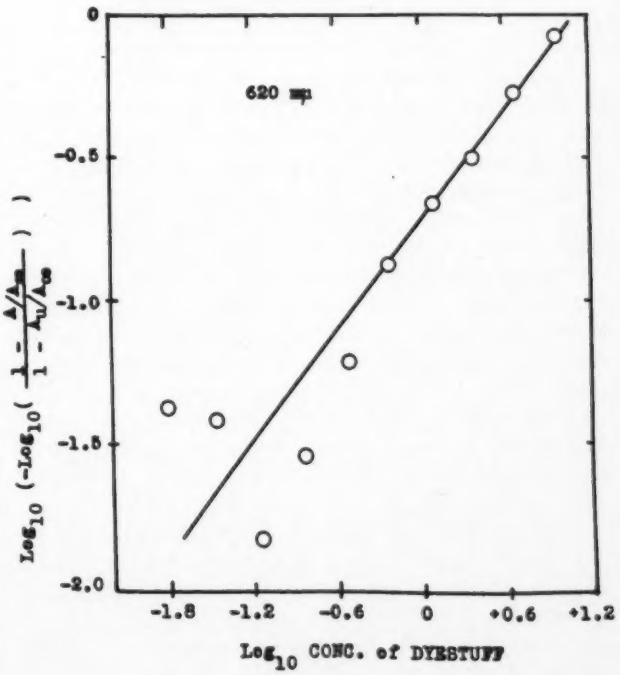


Fig. 9

*Surface reflection occurs whenever light passes from one medium to another medium having a different index of refraction, such as in our present case, between air and wool. When discussing the earlier case of dye solutions it was unnecessary to consider surface reflection when light passed from air into the cell containing dye solution because, as was pointed out, a similar cell, containing solvent, was placed in the "standard" beam of the spectrophotometer. Thus all optical effects due to cell and solvent were canceled out.

called Kundt's[10] rule. This rule states that the absorption maximum of a dyestuff is shifted toward the longer wavelengths as the index of refraction of the dispersing medium of the dye is increased. However, as pointed out by Holmes[11], the cases in which the opposite displacements occur equal in number those tending to uphold the rule and little credence can be given this hypothesis. Several other dyestuffs studied in connection with the present work exhibited the same wavelengths of maximum absorption in water solution and when applied to wool, thus bearing out Holmes' observations.

Dyeings have been made at various concentrations with several other woolen dyestuffs for the purpose of testing further the applicability of Equation 3. The reflection curves of each concentration series of these dyeings have been assembled on separate graphs and are shown in Figures 10, 11, 12, and 13. The dyestuffs used were Wool Orange 2G crystals, Fast Light Yellow 2G, Alkali Fast Green, and Acid Fast Violet BG. The reflections and transmissions were measured from both sides of the swatches dyed with these dyestuffs and the results averaged as described for the case of Fast Wool Red GL. Values of A, A_u, and A^∞ have been calculated for the wavelength of maximum absorption of each of the dyeings and values of

$$\log_{10}\left[-\log_{10}\left(\frac{\frac{1-A}{A^\infty}}{\frac{1-A_u}{A^\infty}}\right)\right]$$

have been plotted against $\log_{10}C$ in Figure 14.

While it is felt that the method outlined here may be usefully applied to the problems of dyeing, it is realized that the measurement of both reflections and transmissions might be inconvenient. With this in mind a curve has been constructed from which the transmission of any dyed swatch (at the wavelength of maximum absorption) may be read if the value of the reflection is known. This curve, shown in Figure 15, has been plotted from data presented graphically in this paper and has no established theoretical significance. It is quite probable that it would be necessary to establish a similar curve for each type of cloth to be studied. But once established, it would be valid for any dyestuff with which the cloth was dyed and would materially lessen the number of spectrophotometric observations.

The appearances of these dyed woolen samples under illumination approximating daylight in quality (I.C.I. Illuminant C) have been calculated in terms of Dominant Wavelength, Excitation Purity, and Brightness, and are summarized in Table I. These calculations were made by the procedure described in earlier papers[1, 2], and the computations were greatly facilitated by utilizing the charts

[10]A. Kundt, "Uber den influss des Losungsmittle auf die Absorptionsspectra Geloster absorbierender medien." Ann. Phys. (Leipzig) *4*, 34 (1878).

[11]W. C. Holmes, J. T. Scanlon, and A. R. Peterson, "The Visual Spectrophotometry of Dyes." Tech. Bull. No. 310, U. S. Dept. Agr. 1932.

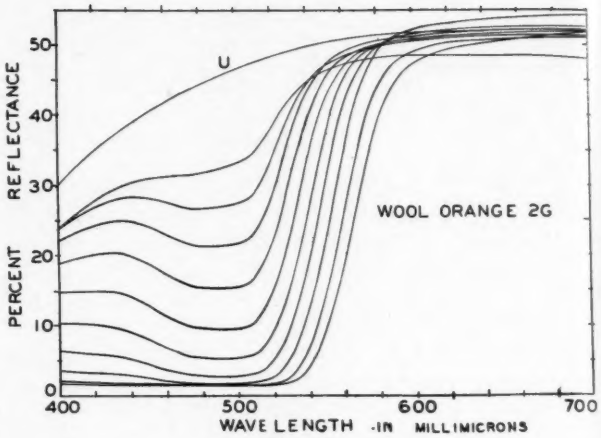
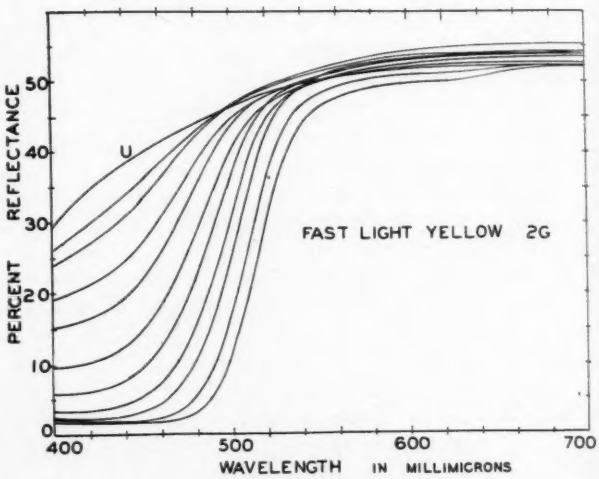


Fig. 10



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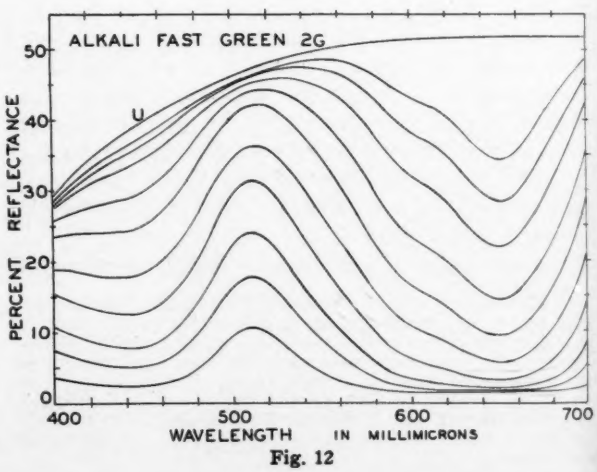

Fig. 12

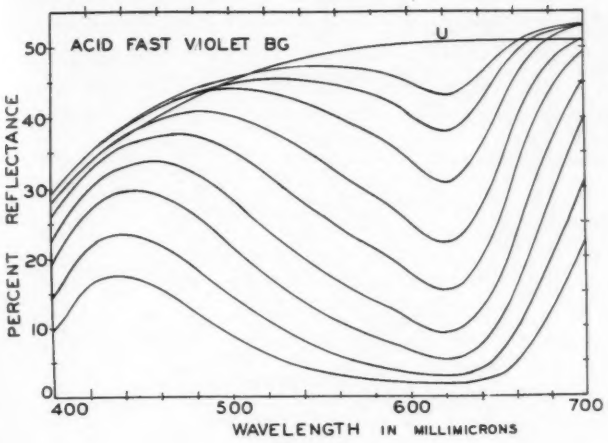

Fig. 13

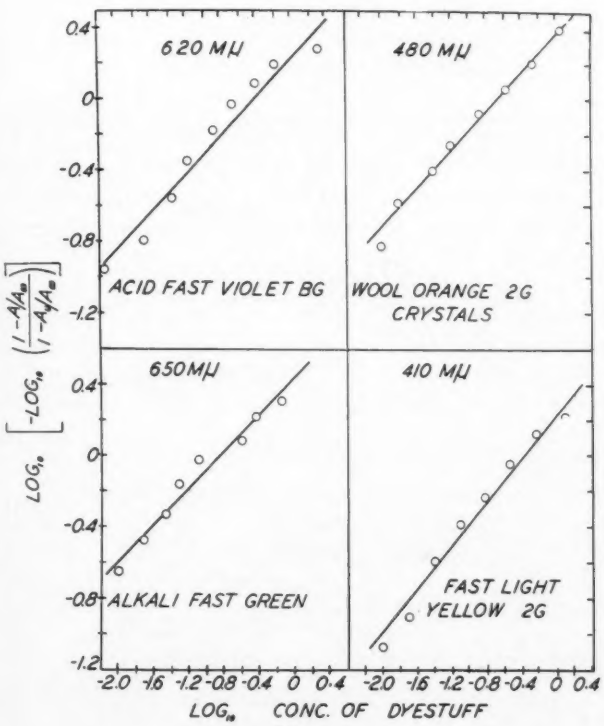

Fig. 14

included for this purpose in the recently published "Handbook of Colorimetry"[12]. The tristimulus values have been plotted on a Chromaticity Diagram in Figure 16 (for I.C.I. Illuminant C) in order to show the progressive increase in Purity and change in Dominant Wavelength with increasing concentrations of Fast Wool Red GL solution backed by an undyed sample of wool. In Figure 17 the various dyeings discussed in this paper have been plotted in the same manner and it is interesting to compare the curves of the red dyestuff in solution and when actually

[12]"Handbook of Colorimetry," 1936 Ed. The Technology Press, Cambridge, Mass.

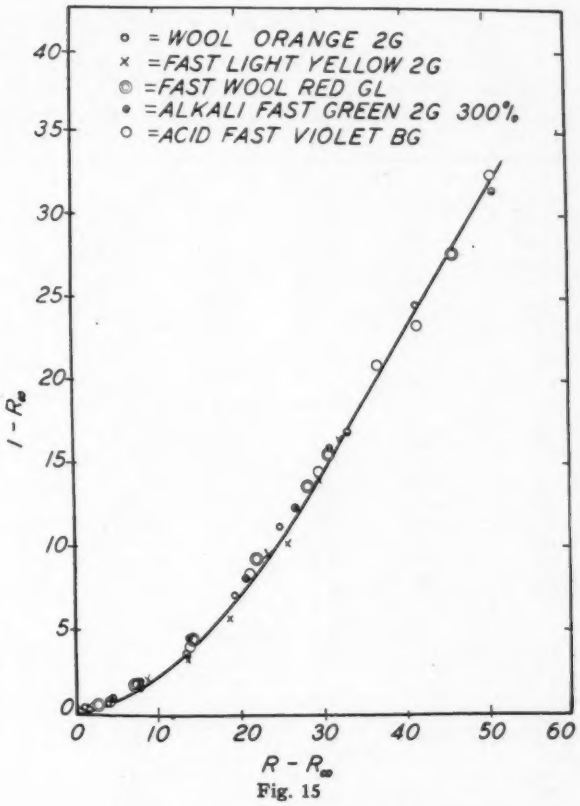

Fig. 15

absorbed by the woolen cloth. The shift in the wavelength of maximum absorption toward the longer wavelengths noted earlier shows up here as having caused the dyed material to have a more purple appearance. In general, it may be observed from Figure 17 that increasing the amount of dyestuff on the cloth above a certain amount does not make the color "stronger," that is, does not increase the Purity. It merely tends to shift the Dominant Wavelength toward the yellow-orange-red portion of the spectrum, with a marked decrease in brightness. This would be interpreted as a trend toward dull brown shades and is in good accord with actual dyeing results.

CONCLUSIONS

An equation has been presented which, to a reasonable degree, correlates the concentration of dyestuff on cloth with the amount of light absorbed by the dyed cloth. This equation has been derived by analogy from certain well known relations applicable to the transmission of light through dyestuffs in dilute solutions. Five series of dyeings have been made under controlled conditions with dyestuffs representing the colors blue, green, yellow, orange, and red. The light absorption of these dyed materials has been obtained directly from transmission and reflection measurements made with the spectrophotometer and this data has been used to test the correlating equation.

This paper has been offered in no sense as the final word on the measurement of color in dyed textiles. It

TABLE I

I.C.I. Illuminant C.

% Dyeing	Trichromatic Coefficients x	y	Dominant Wavelength mu	% Brightness	% Excitation Purity
		Wool Orange 2G Crystals			
0.0102	0.3405	0.3442	579.2	45.21	15.9
.01999	.3688	.3591	583.0	43.03	27.2
.0394	.3850	.3712	582.0	42.22	34.9
.0645	.4080	.3837	582.8	40.21	44.2
.1358	.4402	.3978	584.2	36.22	56.8
.274	.474	.4121	585.1	33.83	69.8
.561	.510	.4182	587.0	30.65	81.0
1.080	.534	.4192	588.3	27.73	87.3
2.24	.556	.408	591.2	23.89	90.2
4.30	.566	.3952	593.5	20.91	89.8
		Fast Light Yellow 2G			
0.010	0.3402	0.3558	574.0	51.34	18.6
.0196	.3443	.3642	572.7	51.72	22.0
.0397	.352	.380	572.0	50.49	28.2
.0799	.3668	.3973	572.8	49.57	37.0
.154	.384	.422	572.8	49.12	48.2
.294	.400	.449	572.3	49.03	59.9
.603	.415	.473	572.3	48.24	70.0
1.150	.440	.489	573.7	46.35	81.2
2.33	.456	.495	574.8	44.00	87.0
4.680	.470	.493	576.3	41.13	90.1
		Fast Wool Red GL			
0.0157	0.343	0.324	596.0	38.36	11.0
.035	.349	.318	610.0	36.78	11.0
.0716	.363	.306	493.5 C	32.36	14.0
.150	.382	.292	495.0 C	25.42	23.0
.306	.413	.279	495.2 C	18.46	34.2
.595	.455	.271	494.7 C	12.29	45.3
1.238	.489	.268	494.3 C	8.82	53.0
2.408	.531	.279	492.9 C	6.49	56.2
4.850	.552	.286	492.5 C	4.53	57.6
9.640	.529	.288	492.5 C	3.10	52.2
		Alkali Fast Green			
0.010	0.311	0.347	552.0	45.93	8.8
.019	.300	.347	529.5	43.66	6.1
.0347	.288	.348	509.5	40.27	7.5
.0476	.272	.350	502.0	35.56	12.4
.082	.254	.357	500.0	29.90	18.6
.258	.239	.365	498.4	23.92	23.7
.3745	.221	.379	499.6	17.62	29.8
.710	.206	.388	499.5	12.27	34.8
2.015	.202	.401	500.6	8.49	35.6
3.135	.213	.411	503.2	4.85	31.7
		Acid Fast Violet BG			
0.007	0.318	0.336	566.0	46.24	7.3
.021	.309	.330	547.0	44.05	3.5
.043	.294	.320	496.5	39.85	5.7
.064	.275	.302	497.5	33.15	12.8
.125	.255	.279	482.5	25.77	24.0
.211	.232	.248	479.6	18.60	36.0
.368	.212	.214	476.8	12.78	47.6
.642	.198	.185	474.5	7.77	56.2
1.975	.193	.158	471.0	4.55	62.3

has been written, rather, with the hope that further work along these lines may be stimulated. The question of dyeing in mixtures of dyestuffs has not even been touched upon, and there still remains the puzzling anomaly of increasing light reflection in the red end of the spectrum with increasing concentrations of dyestuff. The trend toward large scale production with its inherent necessity of more accurate methods of control and closer tolerances is becoming of more importance daily. It is inevitable that some such methods of control will be adopted, and it is recommended that dyers, and colorists generally, avail themselves of the latest developments for the attack on problems of color measurement.

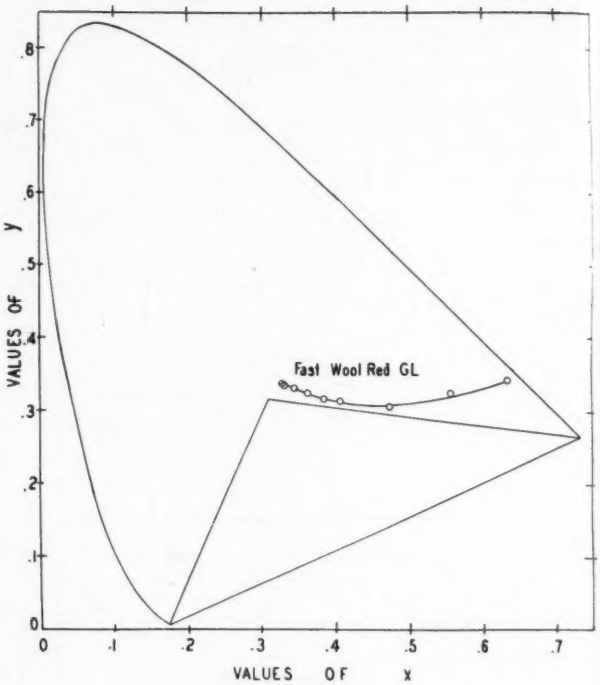

Fig. 16

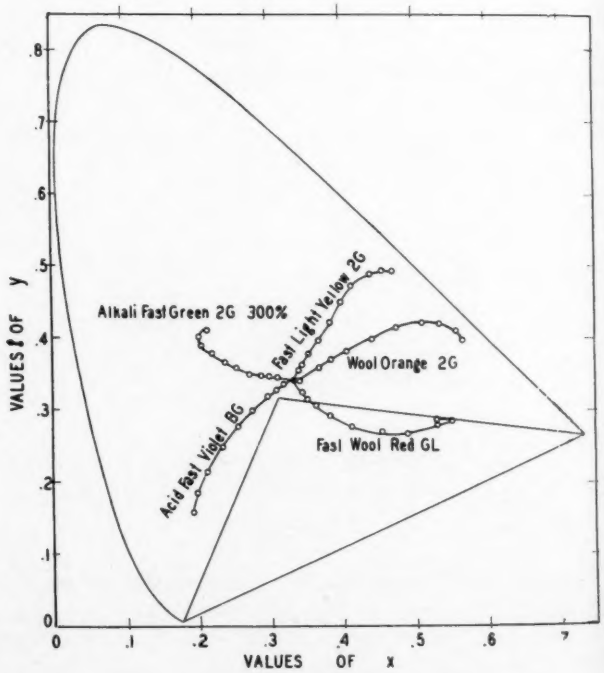

Fig. 17

ACKNOWLEDGMENT

The author wishes to express appreciation for the facilities placed at his disposal while conduction this work at the Massachusetts Institute of Technology. In particular, he wishes to acknowledge the assistance and cooperation of Professor Arthur C. Hardy and members of the Color Measurement Laboratory of the Institute.

PROCEEDINGS OF THE
American Association of Textile Chemists and Colorists

NOVEMBER 2, 1936

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Tentative Technical Program for Annual Meeting

Providence, Dec. 4 and 5, 1936

(Subject to change)

A. W. Buhlmann of A. W. Buhlmann, Inc.—"Are We Making Any Progress in the Textile Industry?"

Professor A. C. Hardy of Massachusetts Institute of Technology—"The Applicability of Spectrophotometry to the Solution of Problems in the Textile Industry."

Geo. V. Caesar of Stein, Hall & Co.—"Starches and Gums." Illustrated with microphotographs.

Dr. Sivert N. Glarum, A. A. T C. and C. Research Associate at Brown University—"Printing Pastes."

du Pont—Subject and speaker to be announced later.

Bernice E. Jamieson of Rhode Island School of Design—"Art in Textile Design."

Republic Steel Corporation—"Application of Stainless Steel in the Textile Industry."

Republic Steel Corporation—Moving pictures of manufacture of stainless steel.

Calco Chemical Co.—Subject and speaker to be announced later.

Professor Wallace R. Brode of Ohio State University—"Relation of Structure to the Light and Wash Fastness of Dyes."

Mr. L. T. Howells of Cowles Detergent Co.—"Reactive Groups in Wool and Their Industrial Significance."

Röhm & Haas Co.—Subject and speaker to be announced later.

UNEMPLOYMENT REGISTER

Members of this association, who are without employment, should forward to the secretary a statement as to their qualifications and experience. This information will subsequently appear on these pages with an identifying key number. Employers are also requested to file with the secretary or the American Dyestuff Reporter any vacancies which may occur in their businesses.—H. C. Chapin, Secretary, Lowell Textile Institute, Lowell, Mass.

Key: A—Laboratory and research; B—Dyeing or printing; C—Finishing; D—Sales; E—Instruction; F—Executive.

NOTE: PERSONS WHO HAVE OBTAINED EMPLOYMENT SHOULD NOTIFY THE SECRETARY OR THE AMERICAN DYESTUFF REPORTER AT ONCE. Prospective employers may file vacancies either with the secretary or the American Dyestuff Reporter.

A-B-2

Education—Lowell Evening Textile School, 1917.

Experience—Five years' experience in hosiery dyeing, full fashioned hosiery of silk and cotton and silk, also men's hosiery containing rayon, wool, cotton and celanese. Several years experience in laboratory work. Has also had experience in jig-dyeing of cotton piece goods, slub and top dyeing.

A-B-5

Education—Graduate of the University of Lausanne, Switzerland. Doctor's degree in Chemistry. Knowledge of French and German.

Experience—Eleven years with large bleaching, dyeing, printing and finishing plant as assistant Chemist and then Chemist in charge of the Laboratory. Experience in dyeing and printing cotton and rayon fabrics; research and analytical work. Woman.

A-B-7

Education—Evening school in textile dyeing.

Experience—2 years laboratory in dyehouse; 9 years dyer and foreman on hosiery, ribbons and rayon; 2 years assistant to superintendent. Can handle help efficiently. Desires position as supervisor or demonstrator of dyestuffs. Age 30; married. Prefers vicinity of New York.

A-B-C-2

Education—Graduate of Lewis Institute of Engineering of Chicago and graduate of Philadelphia Textile School (Chemistry and Dyeing department).

Experience—Has had extensive experience as assistant chemist and colorist in silk printing, dyeing and finishing; also dyeing raw stock wool; and dyeing and finishing cotton and rayon. Age 30; married; references.

A-B-C-3

Education—3 years at Brown University and Drexel Institute.

Experience—2½ years in dyestuff laboratory; 3 years as second-hand, dyeing indanthrene and direct colors on rayon skeins; 6 months as boss dyer on silk and cotton ribbons and hosiery; 3 years overseer of dyeing and finishing rayon tubing. Can handle laboratory, dyehouse, finishing or outside service. Age 30; married.

A-B-C-D-E-1

Education—B.S. Chemistry, Mass. Institute of Technology.

Experience—Plant and laboratory work. Knowledge of wool scouring; cotton, worsted, celanese and rayon slashing; bleaching, dyeing, printing and finishing of cotton cloth; printing of Plissé; manufacture of soaps, finishing compounds and wetting-out agents; analytical work; solution of mill manufacturing difficulties; dyestuffs and their application to wool, cotton, rayon; textile teaching experience; paper mill work; some sales experience; references; married; 43 years old.

A-B-C-F-1

Education — Five years chemistry and engineering, Brown University (Evenings).

Experience—1 year general superintendent at print works (shirtings, dress goods, etc.; cotton and rayon). 12 years chief chemist and superintendent of large bleachery and dyeworks (cotton, rayon and silk piece goods). 4 years chemist in charge of control work in bleach, print and dye works (cotton, wool and rayon piece goods). 9 years chief chemist and assistant superintendent in gas and oil manufacture. Practical dyer and finisher and can handle help efficiently and get results. Can help a plant seeking to improve their vat dyeing, shrinkage results, finishes and service to customers. Age 45; married.

Copies of the
1935-6 Year Book
of the
American Association
of
Textile Chemists
and
Colorists
are now being mailed

A-C-1

Education—4 years at Newark Evening Technical School in Chemical Engineering.

Experience—8 years in manufacturing, research, testing of soaps, oils, gums and finishes and application of same in all phases of the textile industry. Age 23, single. References.

A-E-1

Education—Ph.D., Univ. of Illinois, studied chemical engineering at Columbia, licensed chemical engineer, New Jersey.

Experience—10 years' experience teaching in colleges, subjects included chemical and textile subjects. Has had broad experience in industrial work including experience in testing materials, research and consulting. Will go anywhere; references.

B-1

Education—Educated and trained in chemistry and calico printing in Glasgow, Scotland.

Experience—Has been with large print works as colorist for 13 years producing first class work on cotton, rayon, wool and silk fabrics. References.

B-3

Experience—Foreman piece dyer for the past 21 years. Can dye the following: celanese, rayon, cotton backs, wool, silk and mixed fabrics. Has knowledge of finishing and laboratory work.

B-6

Education—Graduate R. I. School of Design.

Experience—5 years in bleachery, 7½ years as assistant dyer, 2 years as boss dyer and 3 years as superintendent of dyeing and finishing. Married, 33 years old. References.

B-7

Experience—Eight years as boss dyer on skeins and ribbons. Over ten years as chemist and head dyer for a large hosiery mill. Experienced on Silk, cotton, rayon and wool in skeins, ribbons, piece goods and all kinds of mixtures. Willing to go anywhere. Not afraid to work or face responsibility. Can handle help efficiently.

B-8

Education—Chemistry and Dyeing Department, Philadelphia Textile School.

Experience—Eleven years experience as chemist and boss dyer on the following: woolen, worsted and cotton yarn; woolen, worsted and union piece dyes on both ladies' and men's wear; wool, cotton, shoddy and mohair raw stock. Age 33, married, will go anywhere. References.

B-9

Experience—Hosiery dyer with fifteen years' experience on high grade silk hosiery; familiar with all types of machines. Age 43, married. Will go anywhere.

B-17

Education—Lowell Textile Institute (Chemistry and Dyeing Course) 1916; extension courses at Brown University.

Experience—6 months dyeing wool at finishing company; 2½ years research work on bleaching, dyeing and finishing at dye works; inspector of textile equipment, U. S. Ordnance Dept., during war; 15 years as superintendent of dyeing at finishing company, including all types of colors on cotton piece goods and some rayon and celanese; handled chemical work at last named plant for many years as well as dyeing. Age 40, married, prefers East. References.

B-20

Education—Chemistry and Dyeing Dept., Philadelphia Textile School.

Experience—Thirteen years' experience as boss dyer on the following: rayon and cotton skein and piece goods and knitted fabrics. Raw stock dyeing in pressure dyeing machines. Age 35 years, married, can handle help efficiently.

CALENDAR OF COMING EVENTS

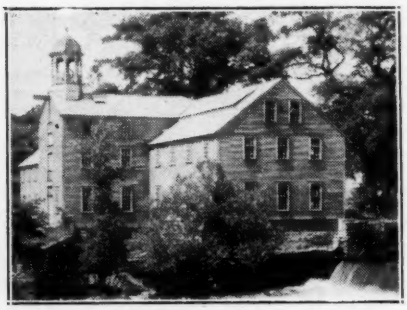
Annual Meeting, Piedmont Section, Charlotte Hotel, Charlotte, November 7, 1936.

* * *

Meeting, New York Section, Chemists' Club, New York City, November 20, 1936.

* * *

Annual Meeting, Providence, R. I., December 4 and 5, 1936.



Old Slater Mill, 1793

Visit the Old Slater Mill, the Birthplace of the Textile Industry in this Country, While in Providence, December 4th and 5th.

Attracted by the rewards offered by Moses Brown and his associates in Rhode Island, Samuel Slater came from England in 1789 and started the first successful manufacture of cotton by power machinery in the United States. Forbidden to export machinery and unable to bring drawings or models from England, Samuel Slater had to memorize the Arkwright designs and mechanisms and reproduce the machinery before he could start manufacturing. The original plant had three cards, drawing and roving frames and two spinning frames. The mill pictured above was erected in Pawtucket in 1793. Other Slater mills were erected in Slatersville in 1803 and in Webster, Massachusetts in 1811, where Slater mills are still in operation.

The first recorded "coloring business" was carried on in Pawtucket in 1805-1806 by the Merry Brothers, who had a room set aside for the printing of Calicoes.

Providence soon became the center of a growing industry and by 1850 the streams of Rhode Island were dotted with many mills. Other early mills include Jacob Dunnell's built in 1836 and Sayles Finishing Plants in 1847.

Today, Rhode Island is America's most highly industrialized state. Textiles still lead in value of products with worsteds now surpassing cotton.

SIXTEENTH ANNUAL MEETING AND CONVENTION OF THE A. A. T. C. C.

PROVIDENCE BILTMORE HOTEL

AUSPICES OF RHODE ISLAND SECTION

AMERICAN
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MYRON DREW REESER
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Published biweekly by
HOWES PUBLISHING CO., INC.
440 Fourth Avenue, New York City

Subscription price: $5.00 per year; Canadian $6.80, foreign, $6.00

Vol. 25 November 2, 1936 No. 22

GREEKS KNEW THE ANSWERS!

THE ancients had what we would regard as a very queer idea about the world. To them it seemed flat and they thought that it was supported by the god Atlas, who carried it on his shoulders. This explanation usually sufficed, but when pressed to say how Atlas was supported, their wise men said that he stood on the back of an immense tortoise. On what did the tortoise stand? Any one so inquisitive as to ask this embarrassing question was regarded as an unpatriotic, irreligious blaspheming unbeliever. He was lucky to escape being stoned.

As we listen to some of the present-day spellbinders, it appears that their notions about government and economics bear strong resemblance to the ancient cosmology. They seem to believe that the government can and should support all of the people, without realizing that this doctrine immediately raises the question of how the government itself is then to be supported. Any one who asks this question is declared to be a tory, an economic royalist, a friend of Wall Street, a hireling of big business, or an ally of the greatest orge of all, the international banker. Only a believer in private capitalism would think of such a question, and this fact alone would put him beyond the pale.

Our modern economic mythologists apparently do not realize that there is only one way by which both the government and the people can be supported. This is by the maintenance of a large and steady stream of production. Within certain limits the services of government contribute to the size of this stream. Government is only a form of social organization. It is the people acting collectively to perform certain services for themselves and for each other. When these services are rendered, efficiently and economically, government is a factor of genuine importance in the production of wealth.

The expansion of governmental activities, which means an increase of governmental expenditures, must eventually arrive at a point at which nothing more is added thereby to the total product, and if continued still further, the additional activities and expenditures must become a positive drag on production. Thus, protection is essential, but a city can have too many policemen. Education is a valuable public service, but it is possible to spend money wastefully on this activity. So it is with every other governmental service.

Many public administrators and some of the ambitious contenders who would like to supplant those now in office, dislike to face these facts. They prefer to extoll government, to promise ever greater benefits and advantages from a still further development of the scope and expense of the public services. They appear to forget that every penny spent by government must come from the pocket of a taxpayer, and that beyond a certain limit the burden of the taxes far exceeds the benefits of the public expenditures. It requires a high order of political and moral courage on the part of a candidate to say that, if elected, he will spend less rather than more money.

The ancients said that Atlas stood on a tortoise. In the modern economic mythology, government can borrow and spend, or it can print paper money. In this way, it is contended, the benefits of ever greater spending can be diffused without burdening the people through taxation.

This method postpones one difficulty while it creates others. Eventually there must be heavier taxation for the debt service, unless the obligations are to be repudiated. In the meantime, the inflationary effects of the borrowing and spending are likely to lead to price increases, and the results of such price changes will be diffused very unequally. Some groups will gain while others lose. The losers will include both rich and poor. All who receive fixed incomes, whether as interest or as wages, will be doubly penalized, first by the higher prices and second, by the heavier taxes when debt redemption begins.

Grover Cleveland's proposition that the people should support the government rather than be supported by it sweeps away this curious economic mythology as effectively as the doctrine of Copernicus and Gallileo destroyed Atlas and the tortoise. It is time that we grounded our thinking again on this fundamental proposition.—*Harley L. Lutz, Professor of Public Finance, Princeton University.*

The Evaluation of
Textile Waterproofing Agents

*Part III. Measurement of Waterproofness**

ROBERT N. WENZEL†

THE waterproofness of a treated fabric is readily demonstrated by its ability to hold water when formed into a shallow trough and to shed water completely without showing a wetted surface. In many textile mill laboratories an arbitrary qualitative test of this type is the only waterproofness test applied and the different methods employed are almost as many as the laboratories using them. Thus the water may be caused to impinge on the fabric at different angles and in streams that vary from a small trickle with almost no free fall to a forceful stream from a faucet. Or the cloth may be examined after exposure to falling single drops or to a shower intended to simulate rainfall. In one form of the test that has been applied to hosiery, the stocking is squeezed by hand under water and it then shaken out and inspected for wet spots.

Such tests serve a useful purpose in mill operations in defining minimum requirements, but a more exact procedure, one that makes it possible to record a definite numerical rating for the fabric tested, is much to be preferred and is, of course, essential in any experimental study of textile waterproofing problems.

The obvious measure of resistance to penetration by water is the pressure at which water can be forced to penetrate. It is most conveniently determined as the maximum hydrostatic pressure that the fabric can retain.

HYDROSTATIC PRESSURE TEST METHOD

The hydrostatic pressure test for waterproofness has appeared in various forms, of which perhaps the best known is that given in the Year Book of the American Association of Textile Chemists and Colorists[1]. In 1930, Barr[2] described an apparatus and procedure suitable for determining waterproofness in light-weight open fabrics and reported a detailed study of this method and the factors that influence the results. Barr worked with cotton and woolen fabrics. In this laboratory, the successful application of Barr's method to light-weight silks and rayons has been found to require certain modifications in technic, which will be indicated in the present article.

Apparatus

The apparatus used, which is shown in Fig. 12, is essentially as described by Barr. The test specimen is clamped across the top of a flanged brass cup, 2.5 in. in diameter, where it is held in place between rubber mason jar rings by a brass ring plate and thumb screws. The cup connects as shown with a vertical glass tube graduated in centimeters and tenths. A levelling pear provides for rapid adjustment of the water level at the beginning of the test and for draining the column. Water is introduced at the top of the graduated tube at a constant rate. This rate is fixed by causing the water to flow through a constant resistance under a constant head. The resistance is provided by a fine-drawn capillary placed within the bore of a 1 mm. capillary tube having a constriction near the bottom end to hold the finer tube in place. The head above the outlet from the capillary is fixed by the constant level arrangement shown. Different capillaries can be inserted to provide different resistances and the head can be varied by changing the water level or by raising or lowering the capillary tube. The test tube inverted over the capillary makes it possible to lower the water level below the upper end of the capillary tube and also serves to protect the latter from air bubbles in the inlet stream.

Mounting the Test Specimen

In applying this method to open fabrics, the chief obstacle encountered was that water first penetrated the fabric at the clamped edge. Barr attempted to avoid this difficulty by coating the test piece with a ring of paraffin. Water then appeared first at the edge of the paraffin ring, but only shortly before other drops came through at points away from the edge.

With light weight silks and rayons, paraffin applied in this way did not prove at all effective. Other coating compositions having higher contact angles gave better protection at the edge, but required a solvent for their proper application; and in that case it was impossible to avoid an undesirable creeping of the solvent into the

*In Part I of this series This Journal, Sept. 21, 1936, p. 505 the distinction between water repellency and waterproofness was emphasized as essential to a proper understanding of waterproofing effects on fabrics and their evaluation. Water repellency is a physical property of surfaces, the resistance of the surface to wetting by the spreading of water across it. Waterproofness, on the other hand, is resistance to penetration by water and, in the case of an open fabric, depends not only on the water repellency of the thread surfaces, but also upon other characteristics of the cloth, particularly the size of the largest openings through it.

The measure of water repellency is the effective adhesion tension of the repellent surface, which is revealed by the magnitude of its equilibrium contact angle. An apparatus for measuring contact angles and some results obtained with it have been described in Part II (This Journal, Sept. 21, 1936).

†Onyx Oil & Chemical Co. and Mellon Institute of Industrial Research.

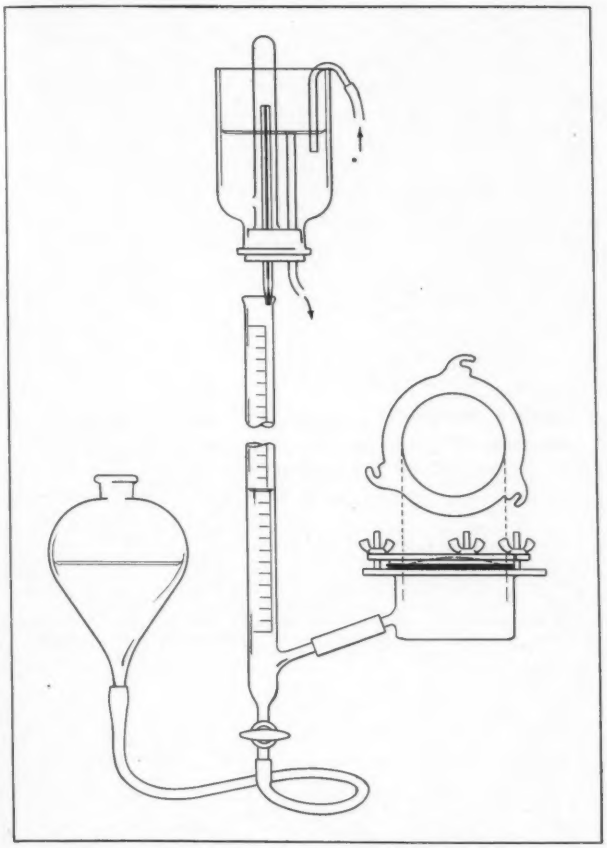

Figure 12. Hydrostatic Pressure Test Apparatus.

area under test. This effect could be minimized by incorporating gums and applying the coating mixture as an amorphous paste, but it was finally discovered that the composition used on ordinary zinc oxide adhesive tape was ideal for the purpose. Rings of adhesive tape pressed with a cold iron to the upper surface of the test specimen thus provide a convenient and effective means of avoiding premature leaking at the edge of the area under test. The new waterproof adhesive tape is to be preferred because drops of water that penetrate the fabric and roll to the edge of the piece do not then spread around the edge by wetting the tape. Rings of 3 in. outer diameter and 2 in. inner diameter are used.*

Rate of Pressure Increase

The pressure attained in any test depends in part upon the rate at which the water pressure is increased. The lower the rate the lower is the pressure attained. Presumably, the longer time of contact at the lower rate increases the effect of water vapor in breaking down the resistance of the unwetted surface. (See footnote, Part 1, p. 509.) Barr reported the values given in Table IX to illustrate this point.

Because he found that slow rates make the differences between different fabrics more marked, Barr adopted a

* Supplied by Johnson & Johnson, through the courtesy of Mr. C. F. Slotter of their Research Department.

TABLE IX

Effect of Rate on Final Pressure (Data by Barr[2])

Edges not Waxed		*Edges Waxed*	
Rate (cm/min.)	*Final Pressure (cm.)*	*Rate (cm/min.)*	*Final Pressure (cm.)*
73	24.5	3.1	16.0
11.2	16.7	0.81	13.4
5.6	8.2	0.38	14.0

rate of 0.38 cm. per min. He considered a rate of 6 cm. per min. unduly high. In this laboratory, rates of 1.5 to 2.5 cm. per min. are used. This practice follows Barr's recommendation as to slow rates, but reduces somewhat the extremely long time per test which his own figures do not seem to justify.

For comparison it should be noted that the A.A.T.C.C. procedure[1] specifies the rather extreme rate of 60 cm. per min. At this rate materials are classified as spotproof if they resist a pressure of 17 cm., rainproof if they reach 50 cm., and waterproof if sufficiently resistant to retain 50 cm. for one hour.

Expression of Results

In Barr's procedure, the waterproofness of the fabric is expressed as the head, in centimeters, at which the first drop of water appears above the fabric.

It may be questioned whether this end point gives a proper comparison between samples, because, after the appearance of a single small drop, the pressure usually continues to rise without change of rate and without evidence of failure at any other point; then a second single drop may appear. Eventually, several such drops, growing rapidly, will cause a falling off of the rate of pressure increase, and finally a sharp downward break in the pressure-time curve. A second sample, following practically the same curve to the same or even a higher maximum pressure, may show a first drop at a pressure several centimeters lower.

The pressure at which the first drop appears is thus a most erratic criterion. The pressure at the appearance of the second drop is a more consistent figure, and, as significant results are only to be had by averaging a number of check determinations, second-drop pressures offer a somewhat more satisfactory end point. Should the second drop appear 5 cm. or more below the maximum pressure reached, it will usually be found to be quite out of line with duplicate tests. In such cases the second drop is also discarded in favor of the third. The justification for this procedure will be apparent in the graphical presentation of test data given in Fig. 13 and discussed more fully below.

Barr took as the point of zero pressure that at which the fabric was just taut. With light fabrics, however, there is considerable bulging and it is difficult to judge this point, especially if there is wrinkling around the edge of the test piece, as there frequently is, at the lower pressures. The amount of bulging will vary with the method of preparing and mounting the sample. It is more satisfactory, therefore, to take the level of the rim of the cup as the zero

point for pressure readings and then, at the end point, to record the pressure head above the center of the test piece, noting also the height of the bulge. These values are readily obtained as follows:

Let A = cross sectional area of the water column (*sq./cm.*) determined by calibration of the tube,

R = rate of increase of head (*cm./min.*) when water is prevented from leaving the tube, (The value of R is controlled by the inlet dropping device and is checked immediately before the test by stoppering the cup with a large one-hole rubber stopper provided with a short glass outlet tube and rubber policeman for removing entrapped air.)

m = lapsed time (*min.*) from zero point to end point,

and n = pressure head (*cm.*) above the rim of the cup at the end point.

Then mRA = water input to the apparatus during time m (*cc.*),

nA = added water retained in the column (*cc.*),

and the difference, A (mR—n) = the volume, V, of the bulge in the test piece (*cc.*), because at the end point no appreciable volume of water has as yet escaped through the fabric.

Assuming now that the bulge has the shape of a spherical segment, which is obviously close to the truth,

$$V_b = 1/24\ \pi\ h(4h^2 + 3s^2)$$

where h is the height of the bulge and s is the diameter of the cup.

In the present apparatus the diameter of the cup is 2.50 inches or 6.35 cm. The above equation then reduced to

$$V_b = 0.524\ h^3 + 15.8\ h.$$

From a curve or a table of simultaneous values of V_b and h based on this equation, the value of h corresponding to any determined value of V_b can be read directly. The pressure head at the center of the fabric is then

$$P = n - h.$$

For light silk and rayon fabrics, h has been found to vary between 0.5 and 2.0 cm. Provision might be made for measuring the height of the bulge direct, or it might be estimated by inspection with sufficient accuracy for routine tests, but its calculation from the test data is simply and quickly carried out as shown above. With uniform handling of the test samples, the value of h does not vary appreciably in duplicate tests, and its magnitude is then important as reflecting the effect of the proofing treatment on the physical properties of the fabric.

The actual rate of increase of head during any test is given by the slope of the data curve for that test. After the first few minutes his slope is practically constant, but less than R, thus showing continued flow of water from tube to cup because of continued stretching of the fabric during the test.

EXPERIMENTAL RESULTS

The method of recording hydrostatic pressure test data is shown in the sample data sheet of Table X.

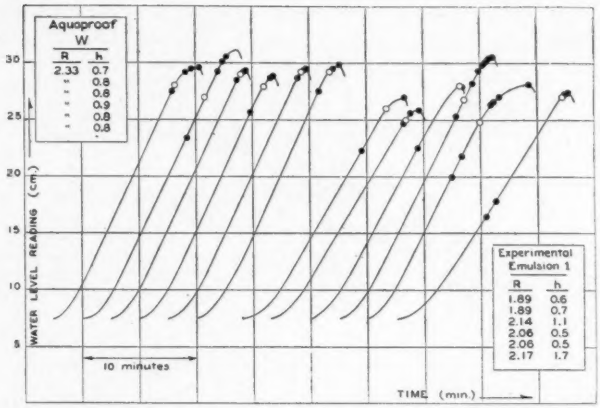

Figure 13. Pressure-time Curves, Hydrostatic Pressure Tests.

TABLE X. SAMPLE DATA SHEET

Run No. 294 — A = 1.93 sq. cm.
Emulsion 259 — R = 2.33 cm/min.
Standard Silk Fabric 2

Time (min.)	*Reading (cm.)*	*Distance from edge (mm.)*	*Notes*
9:35.3	7.50		(Level of rim of cup)
36.2	8.0		
36.9	9.0		
37.5	10.0		
38.6	12.0		
40.1	15.0		
41.5	18.0		
42.8	21.0		
44.2	24.0		
45.5	27.0		
45.8	27.7	5	1st drop
46.0	28.0	3	2nd drop
47.0	29.2	10	3rd drop
48.1	29.6		Maximum press.; 5 holes

At 2nd drop: m = 10.7 min. $10.7 \times 2.33 = 25.0$
n = 20.5 cm. 20.5
V_b = 8.7 cc.
Whence h = 0.7 cm. $V_b = 4.5 \times 1.93 = 8.7$
and P = 19.8 cm.

TABLE XI. HYDROSTATIC PRESSURE TEST RESULTS
(Pressure Head in Centimeters of Water)

	Experimental Emulsions				*Commercial Products*		
	1	2	3	4	*Aquaproof* W	*A*	*B*
On silk	17.7	18.7	17.0	19.2*	19.8	18.5	9.3
	16.8	19.6	19.2*	20.7	18.7	19.5	15.7
	19.4	17.5	17.5	18.8	20.7	19.0	9.2
	18.8	19.6	18.3	17.3*	19.5	17.9	12.3
	16.8*	17.6	17.6	18.1	20.9	18.9	8.8
	17.8*	17.7	17.8	17.4	20.9	18.6	13.6
	17.9	18.4	17.9	18.4	20.1	18.7	11.5
On rayon	13.3	9.7	12.1	16.4	13.6	11.7	
	11.9	11.7	13.7	14.9	14.0	9.5	
	12.6	10.2	11.3	12.8	14.6	7.6	
	10.5	14.4	11.1	12.4	11.3	10.9	
	15.2	14.5	13.3	13.4	11.9	11.7	
	10.8	12.0	10.9	9.7	13.1	11.7	
	12.4	12.1	12.1	13.3	13.1	10.8	

*Third drop pressures, where second drop pressures were abnormally low. Second drop pressures replaced were: for emulsion 1, 13.8 and 9.1 cm.; emulsion 3, 11.2 cm.; emulsion 4, 12.4 and 13.0 cm.

In Table XI are presented results obtained on a number of different emulsions applied to the same silk and rayon fabrics. The first four columns give results obtained with experimental formulas, the last three with established commercial preparations. These results reveal the extent of agreement between duplicate tests.

The large difference between the results for silk and rayon is not to be ascribed to differences in the proofing effect on the two textile fibers, but to the difference in the size of the openings. Theoretically the maximum head that can be supported over a square opening is inversely proportional to the square root of its area. Of the two fabrics here used, the silk has 1.68 times as many openings per square inch as the rayon. If the total area of openings were the same, and their average sizes therefore in exact inverse ratio to their numbers, the head supported by the silk should be approximately 1.3 times that supported by the rayon. Actually there is a fairly constant ratio of 1.4 to 1.5, but this does not hold for commercial product A.

In five of the 78 tests here reported, the second drop pressures were more than 5 cm. below the maximum pressure reached and were therefore replaced by the values for the third drops. These tests are marked with an asterisk in Table XI.

The curves of Fig. 13 illustrate the data taken in the tests of Table XI for Aquaproof W and for experimental emulsion 1 on silk. The points marked indicate the appearance of successive drops on the upper surface of the fabric, the end point taken being designated by a small circle.

The consistency in the slope of the Aquaproof W curves reflects the care used in controlling the rate of water input to the apparatus and the uniform treatment given in ironing and mounting the test specimens. The better agreement between second drop pressures than between first drop pressures is apparent.

In the tests on experimental emulsion 1, pressure rates and the amount of bulging were less uniform, as shown in the data given in the figure, and there are corresponding variations in the resulting slopes of the pressure-time curves. Agreement between the waterproofness results is quite satisfactory, however. The last two tests are instances in which the second drop, as well as the first, appears much too early to be accepted as representing the waterproofness of the piece. Here then we apply the rule that the second drop is also disregarded if it does not fall within 5 cm. of the maximum pressure reached. No test has yet been recorded in which the third drop does not fall within this limit. The third drops in these two tests are seen to agree well with the results in the duplicate runs. It is also apparent that the method adopted gives values in closer agreement than either the first drop or the maximum pressures.

References

[1]Year Book, Amer. Ass'n Textile Chemists and Colorists, 1934, p. 156. Reprinted from earlier editions.
[2]Barr, G., Second Report, Brit. Dept. of Sci. and Ind. Res., Fabrics Co-ordinating Research Committee, 1930, p. 113.

Union Dyeing

Functions and Capabilities of Reserve Agents When Dyeing Low Grade Mixed Fabrics

C. H. A. SCHMITT†

WHILE the use of reserve agents in union dyeing has existed for quite a few years, this product only attained considerable use during the last five years. In the old days when our woolens were all wool and a yard wide, the dyer never had any occasion for using union colors except in the few places where they made cheap woolens, or in mills manufacturing a cotton warp worsted and of course, the worsted was generally virgin wool. In later years came the manipulated fabrics, and how they have been manipulated! We have seen fabrics composed of

(1) white cotton warp with a filling composed of carbonized shoddy;
(2) cotton warp and a filling composed of uncarbonized shoddy;
(3) uncarbonized shoddy and uncarbonized filling, both of which contain silk, rayon, cellulose acetate, copper tinsel, asbestos, paper makers' felt, lastex—

in other words, anything that would pass through a card.

In the old days, working with the white cotton warp and the white worsted or white wool filling, all that was necessary for the dyer to know were a few colors that would dye cotton and not stain the wool much, and then have a few good neutral dyeing colors to fill up the wool. A number of shades could be made by having a cotton color that would dye the cotton and wool exactly the same shade. However, with the manipulated fabrics of today, and the difference in color between the vegetable and animal fibers so great, the proper choice of colors and control of temperature does not give satisfying results.

*Abstracted from an address delivered at the Summer School of the Canadian Association of Textile Colourists and Chemists, held at Hamilton, Ontario, August 17th to 21st, 1936. As printed in *Canadian Textile Journal*.

†Sandoz Chemical Works, Ltd.

DIFFICULTIES OF DYEING BRIGHT COLORS ON MIXED FIBERS

If the cotton threads, or the cotton specks, or the rayon were the same shade as the animal fibers present in the fabrics of today, part of our troubles would be over. For instance, in attempting to produce a bright blue on a grey shade fabric, containing 5 or 10 per cent cotton specks and hard ends, what happens? You all know that the shoddy will soak up the color, completely robbing these white specks, most of which are sewing threads still having a coating of sewing wax, which, therefore, makes absorption of the dyestuff difficult. A simple way of explaining this difficulty is to take a board painted with grey and white stripes and, after it is thoroughly dried, take a paint brush full of a bright blue and paint right over the white and grey stripes, and what is the result? On the white stripes, you have your bright blue, and over the grey stripes, you have a very much duller and darker blue. This is exactly the same condition that is appearing all the time in the dyehouse when you have two different fibers of a different color base. Of course, all the painter has to do is to apply a second coat, and if this does not produce an even result, he puts on a third coat, but, unfortunately, in the dyehouse, we do not apply our colors with a brush, neither can we put them on at different intervals.

It is true that some of our present day dyers are doing miraculous work on these manipulated fabrics; not only are they getting a good result today on a fabric of certain grade coloration, but tomorrow they are getting a quite similar good result on a different style of goods, and on a totally different base. If any man in a mill has a continual headache from changing conditions, it is the poor dyer, from the constantly changing base color of his goods. One thing that has helped the dyer is the wool reserving agent. We, who have been working on the problems of the dyers and mill chemists, have been able to produce some excellent results on the more difficult fabrics through the use of a reserve agent.

FUNCTIONS OF A RESERVE AGENT

Two questions you will naturally ask are

1: On what fabrics does a reserve agent prove of value?

2: What does the addition of a reserve agent to a union dyebath accomplish?

As for the first question, I believe it is safe to say that shoddy fabrics containing cotton warp or cotton specks or threads are the most important field for a product of this kind. Probably next in importance are automobile fabrics, closely followed by upholstery cloths. Another important place where a reserve agent has proved of value is in the production of fancy knitting yarns both in the solid and two tone shades.

As for the second question—what does the addition of a reserve agent to union dyebath accomplish?—I will explain this along with its use in its most important field, shoddy dyeing. We all know that the shoddy in a fabric even in spite of previous neutralizing with ammonia will absorb dyestuff much faster than white wool. Another fact which always works against you in union dyeing, is that so many of the cotton colors which only dye wool slightly, cause trouble because the color that does go on the wool is a very dirty shade as compared to the color on the cotton. On a fabric composed of a cotton warp and a filling of shoddy, the shoddy will absorb the greater part of the direct dyestuff leaving the cotton light and showing up badly.

If a reserve agent is added to the dyebath, it will be absorbed by the shoddy and act as a partial resist, thereby allowing more dyestuff for the cotton. I will try to point out here on the blackboard just what happens with a color like Diamine Brown M (C. I. 420) or Diamine Green B (C. I. 593) on a cotton warp shoddy fabric. Over here we have two columns, one showing cotton and the other shoddy with the relative amount of dyestuffs absorbed by each fiber. In this left hand column, the cotton shows a color value of about 30 per cent, whereas on the shoddy there has been an absorption of color value to give 70 per cent. Naturally with this spread in color tone between the cotton warp or cotton specks and the shoddy, you are not going to have a solid shade and the fabric will "grin" badly.

In an attempt to overcome this condition, the dyer usually adds more direct color in order to bring up the strength of the shade on the cotton—but even using a color with little or no affinity for virgin wool, you will find that the shoddy has attracted the better portion of the addition with the result that the wool shade has automatically become heavier. Of course, he can also pull the plug and drain off part of the dyebath and start speck dyeing at a low temperature and hope that he does not change his wool shade in the bargain.

REDISTRIBUTION OF DYESTUFFS

Now taking the same fabric and dyestuff, and following the simpler method by using a reserve agent, we accomplish this result (shown on blackboard). By partially resisting the shoddy the color value has been cut down from 70 per cent to 50 per cent and the cotton raised from 30 per cent to 50 per cent—giving the balance necessary for a solid shade. I have here a number of dyeings on half wool and half cotton which demonstrate the two-fold action and actual redistribution of dyestuff on cotton and wool of a reserve agent. As I said a minute ago, it first acts as a partial resist on wool, diminishing the stain of the direct color on wool. The second point is that it also exerts a driving action of the direct color into the cotton—in other words, it almost serves as a mordant to attract the cotton color. The colors I have used—Diamine Brown M (C. I. 420), Diamine Green B (C. I. 593) and Benzo Blue RW (C. I. 512), are all colors which normally dye wool much stronger than cotton.

I have here a set of tests showing the redistribution of dyestuff made on skeins of 8 grams uncarbonized shoddy yarn, and 2 grams cotton yarn, and 5 turns pure silk. Dyeings Nos. 1 and 2 show 2 per cent Chloramine Green BC Conc.—dyed for 30 minutes at the boil. On dyeing No. 3, we have used 1½ per cent of a reserve agent.

The amount of dyestuff on the shoddy has by actual test, been cut down to the equivalent of 1.30 per cent or a 35 per cent drop in color value. Now going over to the effect of this addition on the cotton you can see that the tinctorial power of the color has been increased to an equivalent of 2.60 per cent by actual test. Understand that these tests with the reserve agent are all run at the boil for 30 minutes.

I might add here at this point that the high gain of absorption of color by the cotton when using a reserve agent, is more noticeable on those colors which ordinarily dye wool heavier than cotton such as these colors I just showed you. It goes without saying that colors which are not absorbed by the wool, such as Benzo Blue BB (C. I. 406) and Chloramine Fast Scarlets and Stilbene Yellows are not going to have any spare color to be driven on the cotton by the reserve agent. However, you must remember that this condition changes when you are dyeing shoddy instead of wool—so that a color like these last few mentioned which would show no gain on cotton in the presence of virgin wool, would show a gain in the presence of shoddy.

SIMPLIFYING DYEING FORMULA USED FOR SHODDY FABRICS

In recent years we have been able to simplify the dyeing formula on shoddy fabrics by the use of wool reserving agents. For instance, in times gone by, a dyer would use 3 or 4 colors for cotton and possibly 3 or 4 for the shoddy. With a reserving agent we can start off to make a shade with Direct dyestuffs which closely approximate it, regardless of whether or not it is one which ordinarily would over-dye the shoddy leaving the cotton undyed. Take for example, the popular dull greens which seem to run rather regularly for ski suit cloths or cloakings—a great many times we have found that just Direct Green, a reserve agent and a touch of Patent Blue will produce the desired shade as well as having the cotton well covered. All this is possible because of the redistribution of colors between the two fibers when using a reserve agent.

I do not mean to infer that by just adding one-half to 1 per cent of a reserve agent to a dyebath it is going to act like the waving of a wand over it. Everything would be very much simplified if the color of the shoddy was down to the same base and more in harmony with the color of the cotton threads or specks. If we have a condition where the cotton fibers are white and the shoddy is grey or greenish-grey, we go ahead with our redistribution of dyestuff as before to get the proper depth of color on the cotton and add a small percentage of another direct color to dull or change the cotton shade.

If we find it necessary to dull the color on the cotton and a slight amount of this does go on the wool, a touch of an over-bright neutral color will take care of this. For instance, assuming that we have a grey fabric with white cotton or rayon specks, nubs or threads, and we are attempting to produce a ladies' wear Navy with a fairly bright overhand,—if we start out with all Chloramine Black BH on the cotton and no reserve agent, our wool would be altogether too dull and heavy and the cotton light. Adding Acid Violet and Patent Blue would brighten up the wool shade, but the general tone would still be heavy. If we started with Benzo Blue BB (C. I. 406) which does not have the dirty stain on wool that Black BH does, we would keep down the depth of the wool shade, but the cotton specks would be too bright and poorly covered. The thing to do is to go back to our Black BH which gives the proper color on cotton and keep the dirty stain off the wool by the addition of a reserve agent, and brighten the wool with the addition of Acid Violet and Patent Blue.

PRODUCING BRILLIANT SHADES ON WOOL

Sometimes we find that even Black BH does not give a dead enough tone on the cotton and a touch of Stilbene Orange is necessary. If you had your wool shade exactly right and added a touch of Stilbene Orange to a formula which did not include a reserve agent, you are liable to knock the brilliancy out of your wool shade. With a reserve agent in the formula the addition of Stilbene Orange goes to the cotton and stays off the shoddy.

When it comes to the production of the brighter blues on the dull shoddy fabrics, we are running into real problems which are simplified considerably by the use of a reserve agent. Ordinarily you would start with brilliant cotton colors which do not dye the wool heavily—colors like Diamine Sky Blue FF (C. I. 518). It is true that this color has very little affinity for the wool, but when dyed on shoddy it possesses considerable tinctorial power.

By the addition of a reserve agent, the amount of stain is cut down and the full benefit of the bright acid shading colors is gained. In the production of bright shades, the benefits of a reserve agent are appreciated when you can use such brilliant colors as Benzo Blue RW (C. I. 512) and the bright garnets and the brilliant oranges like Chloramine Fast Orange SE. All the colors in this group dye wool much heavier than cotton, and when dyed on a shoddy fabric with cotton present, the shoddy will absorb even more color leaving the cotton almost undyed. By using 1 or 1½ per cent of a reserve agent most of the color can be kept off the shoddy and all of it driven to the cotton.

Some of you will probably say, "Why not lower the temperature of the dyebath, and thereby decrease the amount of stain on the wool made by the direct colors?" In a few cases this may be possible, but you would have to go down to 140° F. or less to keep the color off many shoddy fabrics. As a rule a fabric that does not get a good boil, or a near boil, lacks the penetration with the result that there is more surface dyeing and the goods crock more. I believe you will all agree that the crocking in union dyeing comes from the direct color on the wool rather than the neutral colors, and if the amount of direct color on the wool can be cut down, the fastness to crocking is thereby improved. When you lower the temperature you have to add more neutral color which increases the dyeing

cost more than by using a small amount of a reserve agent. Furthermore, formulae calling for temperature juggling make it very difficult to have every set of goods the same.

CHOICE OF COLORS FOR LOW GRADE WOOL GOODS

As for the choice of dyestuffs to be used with a reserve agent, it is safe to say that that group of colors normally or generally used for dyeing the vegetable fibers and only slightly staining the wool, will work the best.

This group of colors will require the minimum amount of a reserve agent, even under the worst conditions, meaning light cotton and very dark shoddy.

AUTOMOBILE FABRICS

Now let us consider the dyeing of automobile fabrics which amounts to considerable yardage these days. There are two different types of automobile fabrics manufactured. One type is where the wool is dyed in the raw stock with fast to light and fulling chrome colors. This is used for the filling with white cotton warp. It only requires a slight tint on the cotton to match the wool shade. Here it is absolutely necessary that the colors used to dye the cotton do not stain the wool at all. The work is generally done in the piece dye kettle at a low temperature.

All of these colors when dyed at the boil with 1 per cent of a reserve agent show little or no stain, as the dyeings I have here shown. And, at the lowest speck dyeing temperature with a small amount of a reserve agent, the dyer is well assured that the wool color will not be changed. I do not know how much this practice is followed, but I do know of plants where it is done, and the main reason, of course, is that outside of vat colors, it would be impossible to obtain cotton warps possessing the proper fastness to both light and fulling. The sulfur colors and developed colors would stand the severe fulling, but would not have the fastness to light colors, as they would not stand the fulling. Therefore, the reason for the speck dye method.

DYEING MIXTURES OF WOOL, STRIPPED SHODDY AND COTTON

The other type of automobile fabric is usually cotton warp, white wool, shoddy, or a combination, and is dyed by the regular union method. This type of fabric has probably produced more grey hairs on the heads of dyers than any other fabric that has ever come into a mill. Even with the great help rendered by a reserve agent, the problem would be simple if it were not for the fact that the majority of goods made have both virgin wool and stripped shoddy in the filling, with the result that a two-tone is obtained.

Without the proper choice of colors and dyeing method, it is not uncommon for a dyer to find it necessary to use as many as 10 colors in trying to produce a solid shade or the desired two-tone on one of these cotton warp, white wool and shoddy filling fabrics. It is necessary to catch the shade "on the fly" as the dyers say, or else you are in for trouble. If the temperature is allowed to go too high, or the dyeing continued too long, the shoddy will continue to pick up color at the expense of the virgin wool or the cotton fiber. I do not claim that the use of a reserve agent prevents all this trouble, but it does minimize it considerably.

I do not claim to have a fool-proof or guaranteed method for dyeing automobile fabrics of this kind, but we have worked out the line of colors that are suitable, both from the fastness to light angle and that of dyeing properties. I can, at least give you one warning, and perhaps some of you are well acquainted with it, and that is: "Do not depend upon the shade coming up later on. Do not hope that it will look better when it reaches the boil." This fabric has to start right from the beginning. Colors recommended for the shading of the wool on automobile fabrics are colors of slower exhausting rate than the usual neutral colors for unions. If they exhausted too fast, there would be too much chance for unevenness. They must also possess good fastness to light.

Speaking of fastness to light on automobile fabrics, we all realize the automobile trades are most severe in their demands and, of course, you can easily see that they are justified. When the hot summer sun passes through the glass of an automobile, the fading is most severe.

One of the prime requisites of a wool reserving agent for this type of work is that it, too, has an excellent fastness to light; that is, the wool reserving agent must not discolor or have any adverse effect on the fastness to light of the dyestuffs used. A good reserve agent will not turn brown on exposure to light, neither will it cause fading of other dyestuffs.

Such excellent colors as Alizarine Blue SKY or Rubinole can have their fastness badly impaired by the use of an inferior wool reserving agent in union dyeing. A one-half per cent dyeing of Alizarine Blue SKY can be exposed to one week of sunlight or to 16 hours in the Fade-Ometer without any material change. With one-half per cent of a reserve agent added, there is no change. However, if an improper wool reserving agent is used the clear shade of the Alizarine Blue SKY, after this short exposure, would be slightly browned. This, of course, is not due to the effect on the color, but just that the wool reserving agent itself turns brown when exposed to light.

GENERAL SPECK DYEING

Let us now take up the use of wool reserving agents in the ordinary everyday speck dyeing. When it comes to the speck dyeing or burl dyeing of blue serges or dark colored goods, any of your logwood base or aniline speck dyes are satisfactory. When it comes to speck dyeing of some of your acid dyed flannels or ladies' wear crepes of light construction and bright colors, the use of 6 to 8 ounces of a reserving agent per piece is most beneficial. If there is a slight absorption of speck dye on a blue serge, no one will ever notice it. This same amount of stain on a light brown, pale blue, or coral shade would be another story.

On the lighter 8 to 10 ounce fabrics, a higher amount

of soda ash, as is generally used in speck dyeing, is prohibitive, making the goods harsh and not keeping the color off the wool as much as most people think it does. Soda ash is liable to pull off a small percentage of wool color. If the man on the washer doing the speck dyeing should accidentally run in too much hot water, there is apt to be a slight stain on the wool. However, if you were using a reserve agent, 10 to 20° higher temperature would make little or no difference. It is always recommended to put the reserve agent into the bath before the dyestuffs, allowing the wool to pick up the reserve agent properly, resisting the color which is to follow it.

I have here a speck dye black composed of the usual aniline colors for this work.

No. 1 shows the regular dyestuff and common salt.

No. 2 with the addition of soda ash.

No. 3 using a reserving agent instead of soda ash.

The dyestuff on the white wool is practically nil, and the cotton very much heavier than either the dyeing without a reserving agent or with soda ash. By using a reserving agent in speck dyeing, it minimizes unevenness. If acid dyed pieces are improperly washed, allowing excess acid to be left in certain parts of the goods, the speck dye is naturally going to be attracted to these spots and cause blotchiness.

TWO-TONE EFFECTS

While the production of two-tone fabrics or multi-color effects can be carried on extensively in stock dye mills, the possibilities of producing similar effects in low-grade piece dye mills has been rather neglected.

Of course many plants are mixing resisted silk specks and fast to cross-dyeing Celanese into their carbonized shoddy to obtain fancy effects. But think of the possibilities of producing smart colorful fabrics by the combination of white rayon with carbonized shoddy, or, if better quality goods are desired, white wool or noils. The shoddy or white wool can be dyed one color and the rayon another. Contrasting colors naturally show up better. These two-tone effects, or three-tone effects, with cellulose acetate can be dyed either in one or two baths. The two-bath process is followed more on the Continent where the extra time is not such an objection as over here. In this process the wool is dyed with acid colors which do not stain white cotton. It is well rinsed after dyeing to remove all traces of acid. The cotton is then dyed with Direct Colors at 120-140° using one-third per cent of a reserving agent.

Most excellent results can and have been obtained in producing two-tone effects with the one-bath method using a reserving agent. The colors recommended are those direct colors I previously mentioned which leave wool white or nearly white with a reserving agent at the boil or near boil.

For the wool, we must use colors which not only give full value with a reserving agent, but must not stain cotton or rayon, as the case may be. However, as in solid shade work, because of the original shade, it sometimes becomes necessary to use neutral colors in the lessened tinctorial groups but above all things, be sure they leave cotton or rayon white. For instance, here is an example of what might happen if a dyer tried to dye the cotton or rayon yellow and the wool a navy shade, using a reserving agent with the improper neutral color, or as in this case, Sulfur Cyanine. Sulfur Cyanine would completely ruin the brilliant yellow color of the cotton or rayon. In two-tone dyeing pick your wool colors with their staining or vegetable fibers in mind.

ONE-BATH METHOD OF OBTAINING TWO-TONE EFFECTS

The method of dyeing two-tones in one bath is as follows: After the pieces are sewed in, the requisite amount of reserving agent previously dissolved is added to the bath; the amount of water being the same as in regular union dyeing. The pieces are allowed to run 5-10 minutes before the dye is added. This gives the wool a chance to pick up the reserving agent and give a more efficient reserve. The dye is then added, followed by the salt, and goods run another 10 minutes before turning on steam. Raise to the boil and run 30 minutes or until desired shade is reached on wool. If cotton or rayon needs shading this is done at the lower temperature providing the formula has sufficient reserving agent. One per cent reserving agent is generally enough although in a few rare cases due to the fabric or choice of colors, 2 per cent may be necessary. When the desired shade is reached the goods are washed off as usual.

The two-bath or speck dye method of dyeing two tones offers a wider range of acid colors because the cotton or rayon is left whiter in the acid bath.

The mill making two tones by the simple one-bath method can weave any number of pieces in one style, send them down to the dyehouse and turn out any number of fancy combinations.

Here are a number of fabrics all dyed by the one-bath method—boys' suiting—flannel shirting—baseball uniform cloth—cap cloth.

Some of the prettiest fabrics turned out by this one-bath process are these knitted fabrics, cotton back rayon and mohair face. The fancy yarn dyers, those catering to home knitters find unlimited uses for a reserving agent. Here are a few samples.

Under the heading of two-tone effects and the fabrics produced, I might mention the popular coatings of rayon and wool; the rayon dyed and the wool left white. These coatings required fast to light colors and most of this group give poor color value on rayon if dyed at too low a temperature. With a reserving agent in the bath the temperature could be raised and the full color value obtained on the rayon without staining the wool.

MOHAIR PILE FABRICS WITH COTTON BACK

Two methods are followed for dyeing this fabric. Some mills dye the mohair in the piece with acid colors, rinse off and then speck dye at low temperature with a reserving agent using the proper fast to light colors—or if low grade goods—the cheaper colors leaving wool white.

The other process followed is the regular union method. If excellent fastness to light is desired, the proper fast to light direct colors are used in conjunction with a reserving agent shading the wool with fast to light neutral dyeing colors. The choice of colors used in this method follows very closely those used on union dyed automobile fabrics. Inasmuch as mohair seems to have a stronger affinity than wool for direct colors, it is, therefore, more difficult to keep the mohair from staining when following the speck dye method.

SPUN RAYON AND WOOLEN DRESS GOODS

This past season there has been considerable interest in fabrics composed of 80-90 per cent Spun Rayon and 10-20 per cent Wool. A fair amount of goods were made up into solid shades which did not offer any great problem in dyeing. However, the demand for this fabric where the rayon was to be dyed and the wool left white gave a little trouble until the dyers were provided with the proper colors and the thought of keeping the colors off the wool with a reserving agent.

While a fairly white wool can be obtained by dyeing the rayon at low temperatures, it is not possible to get such level results as when run at a temperature of 160° F. Furthermore, all the colors leaving wool white at low temperatures would not show good tinctorial value. The result is that most of this type of goods were dyed at the higher temperatures, controlling the amount of stain on the wool with a reserve agent.

BOOK REVIEWS

The Handbook of Chemistry and Physics. 21st Edition. Chas. D. Hodgman, M.S., Editor-in-Chief, published by the Chemical Rubber Publishing Co., Cleveland, Ohio, 1936. Pages, 2,028. Price, $6.00. Special price to teachers and students.

The Twenty-first Edition of the Handbook of Chemistry and Physics represents a 23 year accumulation of useful data for the chemist, physicist and engineer. It is not only acceptable but highly essential in the commercial, educational and research laboratory.

This Handbook is now accepted as occupying an extremely important field and is undoubtedly the most complete and authentic guide and reference handbook in the field of chemistry and physics. Among other things it is the constant revision of this book which makes it so valuable and it is only a matter of two or three years when all obsolete references are eliminated and the text is completely revised and brought up-to-date.

This Twenty-first Edition of the Handbook of Chemistry and Physics involves 175 pages of new composition entailed by complete revision of several important tables.

The Mathematical Section presents several new features.

The collection of laboratory arts and recipes has been completely revised and enlarged by material sent in by a large number of contributors in charge of or associated with educational or commercial laboratories.

The photographic section has also been much enlarged and revised. The tables occupies 17 pages covering a very wide range of properties, relating to commercial plastics. Other features include:

A table of Physical Constants of over 5500 Organic Compounds named by Dr. Austin M. Patterson in accordance with the rules of the Committee on Organic Nomenclature of the International Union of Chemistry.

A formula Index of Organic Compounds in which some 5500 Organic Compounds are listed according to their empirical formulas and refer by number to the compounds given in the table, Physical Constants of Organic Compounds.

For convenience the book is divided into five more or less complete sections which are properly separated from each other by colored inserts.

1. Mathematical Tables
2. Properties and Physical Constants
3. General Chemical Tables
4. Heat, Hygrometry, Sound, Electricity and Light
5. Quantities and Units—Miscellaneous Tables.

Modern science has rendered chemistry and physics almost inseparable and any reference handbook is incomplete that does not combine both to an equal extent. Students of chemistry and physics and also all laboratory workers whether they be chemist or physicist will find this latest edition of the Handbook of Chemistry and Physics a satisfactory and complete reference book for both subjects. A handbook of this kind is quite essential for the chemistry student of today.

Official American Textile Directory, 1936, Fortieth Edition, McGraw-Hill Publishing Co., New York, 640 pages.

The newest edition of this standard directory is divided into six parts as follows: Part I—alphabetical listing of all the textile mills in the United States and Canada; Part II—mills are grouped geographically in alphabetical order under cities and towns by states and provinces, with maps showing the location of these textile cities and towns. Each mill is covered by a full report including capitalization, officers, superintendents, purchasing and selling agents, products, facilities and equipment, horsepower generated and bought, material regularly purchased, and branch or parent mills; Part III—yarn spinners alphabetically listed according to product; Part IV—a new section, listing yarn dealers both under product and geographical classifications; Part V—listing dyers, bleachers, finishers, printers, etc.; Part VI—listing commission spinners, winders, weavers, etc., classified as to type of work and geographical location. The listings presented are compiled from records progressively maintained and corrected daily throughout the year.

As to mechanical details the pages this year have been printed on special, new, thin paper and in three columns instead of two to increase ease of handling. Information about each mill has been tabulated in standard arrangement so that any specific item in connection with a mill may be found at a glance without having to read all about that mill.

NEW PRODUCTS—TRADE NOTES

• NATIONAL RELEASE

National Aniline & Chemical Co. announces release of the following bulletin:

National Erie Black NRG — a direct black similar in properties to the well-known National Erie Black NR Extra and is intermediate in shade between it and National Erie Black NCW. It is said to possess generally good fastness, to have good solubility and to be an excellent cold dyeing color. It is recommended by the manufacturers for unions — dyeing the wool appreciably redder but nearly as strong as cotton—for linings and acetate white effects. For the latter it stains slightly but is said to clear readily. It is stated that it also dyes tin-weighted silk fairly well and discharges readily with hydrosulfite. Bulletin No. 203.

• GENERAL RELEASES

Five new dyestuffs have just been introduced by General Dyestuff Corporation:

Indanthren Grey MG Powder Fine for Dyeing—a new vat dyestuff which yields considerably greener shades than Indanthren Grey M with which it corresponds in its fastness properties.

Indanthren Grey MG Powder possesses excellent fastness to light, excellent fastness to washing and very good fastness to chlorine.

When writing for copy of circular mention I. G. 1236.

Para Yellow RL—a direct dyestuff which when aftertreated with Nitrazol CF or diazotized Paranitraniline produces reddish yellow shades of excellent dischargeability and good fastness to light and to washing.

When writing for copy of circular mention I. G. 1217.

General also announces the release of a new sulfur dyestuff of General Aniline Works manufactured under the name of *Katigen Brown RON Conc.* This dyestuff produces on cotton as well as on rayon bright shades of a full brown of good all around fastness. Its good level dyeing properties and its excellent solubility make it suited for dyeing in all types of machines. It can be applied equally well on raw stock, yarn, warps, beams and on piece goods.

Katigen Brown RON Conc. can also be supplied in the "CF" form to meet the specifications of the U. S. Rubber Association. Copies of this circular are available upon request.

For further information request circular G-155.

Rapidogen Red Violet RR—an easily soluble Rapidogen brand, producing bright red violet shades of good fastness to light and very good fastness to washing and chlorine.

Write for circular I. G. 1225.

Indanthren Olive Green BA Paste—a homogeneous vat dyestuff recommended for the dyeing of cotton and rayon in its various forms.

Indanthren Olive Green BA Paste possesses excellent fastness to light, to washing and to chlorine and is especially suited for the production of olive green shades. It is best dyed according to the IN process, but may also be applied by the IW process, if combinations with other Indanthrens should require it.

On account of its good solubility, it is very well suited for the dyeing in machines, and gives good results in pigment padding.

Indanthren Olive Green BA Paste is chemically identical with Indanthren Olive Green B Powder Fine for Dyeing. Five parts of the Paste type equal one part of the Powder Fine type in regard to tinctorial strength.

Swatch cards can be obtained by mentioning G-154.

• NATIONAL INTRODUCES

The National Aniline & Chemical Company now offers the trade *Magma Chrome Blue Black B.*

This is a new addition to their line of direct dyes, and it is claimed to yield good fastness to sunlight and washing and excellent fastness to perspiration, stoving, sea water and acid.

Aftertreatment with copper, chrome and acetate, renders the shade greener and duller, but considerably improves the fastness to washing and sunlight.

It is suitable for a variety of purposes, especially in unions in which cotton and rayon are dyed, and silk and wool are heavily stained.

Acetate silk effects, although appreciably stained, clear readily.

Excellent whites are obtained on cotton and rayon with a hydrosulfite discharge.

Another National product just released is *Fast Blue WF.* This new dyestuff is of the milling class, producing midnight blues to blue-black on wool, pure and tin-weighted silk in a neutral or weakly acid bath.

It withstands a prolonged boiling bath better than most dyes of this class; it possesses excellent solubility, is of excellent fastness to sea water, washing, carbonizing. perspiration and rubbing and good fastness to fulling and alkali spotting. Its light fastness is fair. A hydrosulfite discharge produces excellent whites in all fibers.

The properties of *Fast Acid Blue WF* recommend it for the dyeing of slubbing, printing yarns for bathing suits and sweaters, hosiery, as well as yarns for embroideries, trimmings and fancy threads.

• HART PRODUCTS CHANGES

Mr. Samuel Lehrer, formerly vice-president of the Hart Products Corporation in charge of sales for the Southern Territory, has recently resigned his position with the company. Mr. Lehrer is now making his home in New York City, where he is engaged in another line of business.

Mr. Charles C. Clark of Spartanburg, S. C. has been appointed Southern Sales manager and he will be assisted by Mr. Talley W. Piper of Fairfax, Alabama. Mr. Clark has been associated with the company for the past twelve years and enjoys the confidence and goodwill of a wide circle of friends and acquaintances, both in the mills and among the traveling fraternity who will be glad to learn of his promotion. His many years' experience as salesman and service-man justly entitles him to the reputation he has of being one of the most competent and trustworthy men in his particular line of work. Mr. Clark will make personal contacts with the trade in the Carolinas, Eastern Tennesse and Virginia.

Mr. Piper who will contact the trade in Georgia, Alabama, Mississippi and adjacent states, has had an extensive experience in bleaching and finishing and was at one time connected in an operating capacity with one of the best known towel mills in the country—famous for the quality of their merchandise. Previous to his mill-employment Mr. Piper worked for Stone and Webster in the engineering department, where he acquired considerable experience in the designing and construction of plants and equipment.

• BROWN INSTRUMENT ANNOUNCES

The Brown Instrument Company, Philadelphia, Pa. has just published a new catalog on Brown Thermometers and Pressure Gauges.

This new catalog covers the complete line of Brown Thermometers and Pressure Gauges—Indicating, Recording and Controlling—and enumerates the wide range of industries to which they are applicable. It describes the classes of Brown Thermometers and Pressure Gauges, explains their outstanding constructional features in simple, non-technical language, and presents a detailed description of each instrument of the line.

We will be pleased to obtain a copy of this catalog for any of our readers who request it. Ask for Catalog No. 6703.

Announcements of new machinery for this section should be accompanied by cuts to measure 2¼ inches in width. 133 screen half tones.

• GLYCO RELEASE

The latest edition of "Chemicals by Glyco", published by the Glyco Products Co., 148 Lafayette St., New York, contains a number of interesting additions. In particular, we note the special formulae section where suggested formulae are given of interest to many different industries.

An innovation which should prove of great value to chemists and technicians is the policy of supplying special assortments of chemicals according to classification. For instance, Assortment A consists of the various emulsifying agents manufactured by the Glyco Products Co., Inc. Thus, if a chemist is working on an emulsion problem, he will have readily accessible a series of emulsifying agents which he can easily try for his particular problem.

Copies of the catalogue can be obtained gratis by any chemist or technician on application to the REPORTER.

• ACTIVATED CARBON PATENTS AGAIN UPHELD

Carbide & Carbon Chemicals Corporation announces that U. S. Patents 1,497,543 and 1,497,544, covering activated vapor-absorbent carbons and processes of manufacturing them, were again upheld in a decision handed down on October 20 by Judge Barnes, sitting in the District Court for the Northern District of Illinois. The case involved National Carbon Company, Inc., plaintiff, v. The Western Shade Cloth Company, defendant, and was brought in the interests of Columbia Activated Carbon, which is made by plaintiff and sold by Carbide and Carbon Chemicals Corporation. The defendant was alleged to have infringed both patents by its use of activated carbon purchased in 1927, and, later, in 1933 from the American Solvent Recovery Corporation of Columbus, Ohio.

Trial of the case, which lasted three weeks, was concluded on October 10. During the trial, expert testimony for the plaintiff was given by Prof. A. B. Lamb, head of the Chemical Laboratories of Harvard University. Corroborative testimony was given by Col. Bradley Dewey, in charge of the Chemical Warfare Service defense activities during the World War, and Prof. W. K. Lewis, also of the Chemical Warfare Service and now head of the Department of Chemical Engineering of Massachusetts Institute of Technology. Both of these men testified that the activated carbon covered by the patents saved many thousands of lives during the War, and was an extremely valuable contribution to the American defense against gas attacks. Commercial developments since then have made Columbia Activated Carbon an essential material for many industries; it is important for use in military and industrial gas masks and for the economical recovery of solvents of widely varying kinds.

Attorneys for the parties presented final arguments on October 20, and Judge Barnes immediately rendered his decision in favor of plaintiff. The court held the claims of the patents valid and infringed, and ordered the customary injunction and accounting. A similar decision in the case of Naitonal Carbon Company, Inc., v. Richards & Company, Inc., and The Zapon Company was affirmed on August 10, 1936, by the United States Court of Appeals for the Second Circuit. In this case also, the patents were held valid, and the defendants were adjudged to have infringed the claims in the use for solvent recovery purposes of a carbon made by The Barnebey-Cheney Engineering Company without license from the patentee.

• WATER-SOFTENING FOLDER

The Creative Chemical Company, Friendship Avenue, Bloomfield P. O. Station, Pittsburgh, Pa., has available folders descriptive of their Zeolene Watertone, a product for softening water for textile, laundry and other industrial purposes. It is claimed that it will supply a constant volume of Zero water regardless of how hard the native water supply may be. At the same time, it neutralizes acid contaminations, keeping the pH activity at neutral in the pH scale.

Zeolene Watertone is a combination of neutralizing chemicals as well as softening agent for water. It can be applied to the treatment of water directly in the water lines, feed lines as well as in the suction lines of feed pumps.

• RESEARCH INSTITUTE DINNER

Textile merchants and manufacturers are to be given an opportunity to learn how the "Survey of Production and Distribution Organization in the Textile Industry" is to be conducted by the Wharton School of Commerce and Finance, what are its objectives and what is the cooperation expected from the industry, at the annual dinner of U. S. Institute for Textile Research, Inc., to be held at the Waldorf-Astoria, Thursday, Nov. 5. Dean Jos. T. Willits of the Wharton School will be the guest speaker, and will be introduced by Fessenden S. Blanchard of Pacific Mills, chairman of U. S. Institute's committee on economic research, which organized and is administering the study. It is financed by the Textile Foundation.

Hon. Francis P. Garvan, president of U. S. Institute and the Chemical Foundation, will act as toastmaster at the dinner, which will be served in the Jade Room at 7 P. M. The only other speakers will be Dr. E. H. Killheffer of E. I. du Pont de Nemours & Co., and a professional humorist.

An open research conference, to be held in the Jansen Suite at 2 P. M., will have as its features a discussion of the chemical processing of textiles as affected by drying, and an address by Dr. Wanda K. Farr, of Boyce Thompson Institute, on "A New Viewpoint in the Study of Cellulosic Textile Fibers." The annual meetings of members and directors will be held in the Jansen Suite at 11 A. M.

• MEETINGS, S.C.I.

The American Section of the Society of Chemical Industry has planned the following meeting schedule for 1936-7:

November 6, 1936: Joint meeting with American Chemical Society, Society of Chemical Industry in charge. Chemical Industry Medal award to Walter S. Landis for work in chemistry and economics of fertilizers. Medal to be presented by Dr. D. D. Jackson. Speaker on accomplishments of Medalist to be Dr. M. C. Whitaker.

December 11, 1936: Joint meeting with American Chemical Society. American Chemical Society in charge.

January 8, 1937: Joint meeting with American Chemical Society, Society of Chemical Industry in charge. Perkin Medal award to Thomas Midgley, Jr., for work on anti-knock motor fuels, safe refrigerants, etc. Medal to be presented by Marston T. Bogert. Speaker on accomplishments of Medalist to be Robert E. Wilson.

February 5, 1937: Joint meeting with American Chemical Society, American Chemical Society in charge.

February 19, 1937: Meeting. Speaker, Dr. Wallace P. Cohoe.

March 5, 1937: Joint meeting with American Chemical Society, American Chemical Society in charge.

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